Groundwater Conditions

2002/2003

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WATER OUR MISSION FOR 75 YEARS
Santa Clara Valley Water District

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Executive Summary

Executive Summary

The Santa Clara Valley Water District (District) has managed the groundwater subbasins in Santa Clara County (County) since the early 1930s and is nationally recognized as a leader in groundwater management. The mission of the District is a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective and environmentally-sensitive manner. Effective management of groundwater resources is an essential part of the District's water resource management mission, as the groundwater basin provides nearly half of the County's water supply.

The District has implemented numerous groundwater management programs and activities to ensure groundwater resources are sustained and protected both now and in the future. These programs and activities directly support Board Ends Policies which direct staff to ensure "The groundwater basins are aggressively protected from contamination and the threat of contamination" and that "Groundwater supplies are sustained."

This 2002/2003 Groundwater Conditions Report describes and documents conditions within the County's three groundwater subbasins for calendar years 2002 and 2003. The report summarizes monitoring performed in 2002 and 2003 and presents results and analyses.

Groundwater Use and Recharge

In 2002 and 2003, groundwater use was approximately 40 percent of the total water use in the County. The District's proactive artificial recharge operations help to balance groundwater extraction and ensure the long-term sustainability of groundwater resources. Groundwater production, recharge, and change in storage for 2002 and 2003 are summarized in Tables ES-1 and ES-2.

Table ES-1
Groundwater Production, Recharge, and Change in Storage
Calendar Year 2002

	Santa Clara Valley Subbasin (acre-feet)	Coyote and Llagas Subbasins (acre-feet)	County Total (acre-feet)
Groundwater Production			
M&I	104,100	25,500	129,600
Ag	700	27,500	28,200
Total	104,800	53,000	157,800
Estimated Artificial Recharge	72,000	35,300	107,300
Estimated Change in Storage*	+11,000 to +13,000	-15,000 to -17,000	-4,000 to -6,000

*Change in storage accounts for groundwater production, artificial recharge, and natural recharge occurring from rainfall and other sources.

Table ES-2
Groundwater Production, Recharge, and Change in Storage
Calendar Year 2003

	Santa Clara Valley Subbasin (acre-feet)	Coyote and Llagas Subbasins (acre-feet)	County Total (acre-feet)
Groundwater Production			
M&I	96,200	24,300	120,500
Ag	400	26,000	26,400
Total	96,600	50,300	146,900
Estimated Artificial Recharge	74,800	43,400	118,200
Estimated Change in Storage*	+15,000 to +17,000	+13,000 to +15,000	+28,000 to +32,000

*Change in storage accounts for groundwater production, artificial recharge, and natural recharge occurring from rainfall and other sources.

Groundwater Elevation Monitoring Summary

In general, groundwater elevations throughout the County were high due to 4 of the past 5 years of normal or near normal rainfall and active artificial recharge by the District. Groundwater elevations in the Santa Clara Valley Subbasin index well were near historic highs for the 89-year historical record. Seasonally low groundwater elevations were approximately 60 feet above the subsidence threshold, which is one of the District's performance measures to ensure "Groundwater supplies are sustained" in accordance with Board Ends Policy.

In Santa Clara County, the water supply aquifers (principal aquifer) are mainly located under confining soil layers. This principal aquifer is at a greater depth and is replenished by deep percolation of rainfall and District recharge operations in very specific recharge areas that are hydraulically connected to the deep water supply aquifers. Shallow or first-encountered water is located above the confining soil layers and is dependent upon rainfall, not on the pressure from water located at depth. A nuisance condition of groundwater that is too shallow is related to the amount of rainfall in any given year, and not the supply of water held at depth.

While groundwater elevations in the Coyote Subbasin and Llagas Subbasin index wells remain above the performance measure target elevation , groundwater elevations have been declining for the last several years. Overall, 2002 and 2003 data indicate that the District is exceeding the performance measures established to ensure "Groundwater supplies are sustained."

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[1] Due to significant historical land subsidence in the Santa Clara Valley Subbasin, the District established subsidence thresholds, or groundwater elevations below which subsidence will reoccur, at 10 locations throughout the subbasin. The subbasin is managed to maintain groundwater elevations above these thresholds.

[2] No subsidence thresholds have been established for the confined zone in the Llagas Subbasin. However, at this time the District maintains groundwater elevations at the Llagas index well above the value of 192.3 feet which was recorded in 1987, the year in which the District merged with Gavilan Water District.

Executive Summary

Land Subsidence Monitoring Summary

Monitoring data from 2002 and 2003 indicate that land subsidence in the Santa Clara Valley Subbasin is minimized by the District's proactive groundwater management activities. Monitoring at two extensometers, eight subsidence index wells, and 147 land surface benchmarks in 2002 and 2003 indicates that any residual subsidence that is occurring is within the tolerable range established by the District of less than 0.01 feet per year. Monitoring at benchmark P7 indicates that the District exceeds the related performance measure designed to ensure "Groundwater supplies are sustained."

Groundwater Quality Monitoring Summary

Overall groundwater quality in Santa Clara County is very good and water quality targets are achieved in almost all wells. Table ES-3 summarizes the number of wells for which water quality targets were exceeded in 2002 and 2003. Most exceedances were for secondary drinking water standards or agricultural water quality objectives rather than primary drinking water standards. The most significant exception is nitrate, which continues to be a concern in the Llagas and Coyote Subbasins. Individual detections from individual wells in any given year are not indicative of trends. The number of detections varies pending on the number and location of wells sampled in any given year.

Table ES-3

Wells Exceeding Water Quality Standards (2002-2003)

Constituent	Number of Wells Exceeding Water Quality Standards		Notes
	2002	2003	
Nitrate	33	39	Blending or treatment was necessary in 25 municipal or domestic wells in 2002 and 19 wells in 2003. The remaining wells were upper aquifer zone monitoring wells or agricultural supply wells.
Miscellaneous Naturally Occurring Inorganics	48	44	One well had aluminum concentration above the primary drinking water standard in 2002. All other exceedances were for secondary standards (related to taste, odor, and appearance) and do not pose a health risk.
Boron	14	13	Agricultural water quality objective exceeded.
Selenium	1	0	Agricultural water quality objective exceeded.
Volatile Organic Compounds	1	0	Volatile organic compounds were detected below drinking water standards in approximately 20 wells in both 2002 and 2003.

Executive Summary

Although there is no drinking water standard for perchlorate at this time, the District is actively supporting Regional Water Quality Control Board and community efforts to accelerate the investigation and cleanup of perchlorate contamination in the Llagas Subbasin. To expedite the investigation and assist the community, the District is providing technical and administrative support to the Perchlorate Community Advisory Group and the Regional Water Quality Control Board.

District Board Ends Policy directs staff to ensure "The groundwater basins are aggressively protected from contamination and the threat of contamination." The Chief Executive Officer's interpretation of this policy is that drinking water standards for anthropogenic constituents should not be exceeded in water supply wells. The nitrate standard was the only drinking water standard for an anthropogenic constituent that was exceeded in drinking water supply wells and it was exceeded in a very small percentage of wells. The District continues to implement a comprehensive nitrate management program to monitor nitrate occurrence, reduce consumer exposure to nitrate in drinking water, and reduce nitrate loading throughout the basin. The goal of the nitrate management program is to reduce nitrate concentrations in groundwater over time so that all wells meet the drinking water standard for nitrate. The data summarized in this report show that, for the most part, groundwater management programs achieve the desired end.

Introduction

1.0 Introduction

The Santa Clara Valley Water District (District) has managed the groundwater subbasins in Santa Clara County (Figure 1-1) since the early 1930s and is nationally recognized as a leader in groundwater management. The mission of the District is a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective, and environmentally-sensitive manner. Effective management of groundwater resources is an essential part of the District's water resource mission, as the groundwater subbasins provide nearly half of the County's overall water supply. The District has implemented numerous groundwater management programs and activities to ensure groundwater resources are sustained and protected both now and in the future.

1.1 Background

Since the 1850s, groundwater has been an important component of water supply in Santa Clara County. Historical overpumping of the groundwater subbasin and significant land subsidence in the northern portion of the County led to the formation of the District as the County's groundwater management agency in 1929. Growing populations increased demands on the groundwater subbasin. Land subsidence continued and led to the construction of ten local storage reservoirs, with a combined capacity of 169,000 acre-feet, the importation of surface water, and the construction of three water treatment plants. Today, the District conjunctively manages groundwater and surface water to provide a reliable water supply for the County's 1.7 million residents and its businesses.

Since its creation by the State legislature, the District has worked to minimize subsidence and protect the groundwater resources within the County in accordance with the District Act (California Water Code Appendix, Chapter 60). As stated in the District Act, the District's objectives related to groundwater management are to recharge the groundwater subbasins, conserve water, increase water supply, and to prevent waste or diminution of the District's water supply.

District programs designed to sustain and protect groundwater resources include:

- Groundwater supply management programs that replenish the groundwater subbasins, sustain the subbasins water supplies, help to mitigate groundwater overdraft, and sustain storage reserves for use during dry periods or water supply shortages

- Groundwater quality management programs that identify and evaluate threats to groundwater quality and prevent or mitigate contamination associated with those threats

- Groundwater monitoring programs that provide data to assist the District in evaluating groundwater conditions and managing the groundwater subbasins

Introduction

In 1999, the District Board of Directors established Ends Policies that direct the Chief Executive Officer to achieve specific results or benefits. The following Ends Policies are related to groundwater:

2.1.1. The water supply meets or exceeds all applicable water quality regulatory standards in a cost-effective manner.

2.1.2. The water supply is reliable to meet current demands.

2.1.3. The water supply is reliable to meet future demands as identified in the District's Integrated Water Resource Plan (IWRP) process.

2.1.4. There are a variety of water supply sources.

2.1.5. The groundwater basins are aggressively protected from contamination and the threat of contamination.

2.1.6. Water recycling is expanded within Santa Clara County in partnership with the community, consistent with the District's Integrated Water Resource Plan (IWRP), reflecting its comparative cost assessments and other Board policies.

2.2.2.3. Groundwater supplies are sustained.

The District ensures that these ends are met through proactive water supply management activities and planning. The collection and analysis of groundwater monitoring data are essential to understanding current groundwater conditions and to ensuring that Ends Policies are met both now and in the future. Monitoring data provide information on groundwater elevation, groundwater quality and land subsidence. In addition to providing data on current conditions, groundwater monitoring data are used for predictive analyses using groundwater flow modeling to determine water supply conditions under a variety of groundwater management strategies.

1.2 Report Contents

Section 26.5 of the District Act directs the District to prepare an annual report summarizing the District's activities in the protection and augmentation of water supplies. This requirement is fulfilled through the annual preparation of the Water Utility Enterprise Report. This 2002/2003 Groundwater Conditions Report provides additional in-depth information to describe and document conditions within the County's three groundwater subbasins for calendar years 2002 and 2003. The report documents groundwater supply and use in 2002 and 2003, and summarizes results from the District's programs to monitor groundwater elevation, land subsidence, and groundwater quality. A complete description of individual monitoring programs can be found in the District's Groundwater Management Plan of July 2001, which is available on the District's website at http://www.valleywater.org. This Groundwater Conditions Report also summarizes new groundwater projects and studies, and provides information on new groundwater legislation affecting Santa Clara County.

1.3 Groundwater Management Stakeholders

The California Legislature created the Santa Clara Valley Water District as a Special District with jurisdiction throughout Santa Clara County. A Board of Directors governs the District and is comprised of seven members, five of whom are elected directly by the voters from the County's five supervisorial Districts and two of whom are at-large members appointed by the County Board of Supervisors, one for North County and the other for South County. The members of the Board of Directors represent different geographic areas of the County and they provide a linkage between the stakeholders of that area and the District.

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[1] These Ends Policies were in use during 2002-2003.
For current Ends Policies, please refer to the District Web site at http://www.scvwd.gov.

Introduction

The basin stakeholders include the thirteen public and private water retailers. These retailers extract approximately 85 percent of all groundwater produced in the County. In addition to the thirteen main water retailers, there are more than 6,000 private well owners. The 6,000 well owners include individual residences, small mutual water companies, industry and agriculture.

District staff organizes quarterly meetings of the Water Retailers Groundwater Subcommittee, where District staff and water retailers share groundwater information, discuss current groundwater management issues, and provide information on specific programs or activities within the subbasins. In 2002, the District sponsored Groundwater Subcommittee meetings on April 2, July 10, and October 2.

The following issues were covered during the 2002 Groundwater Subcommittee meetings:

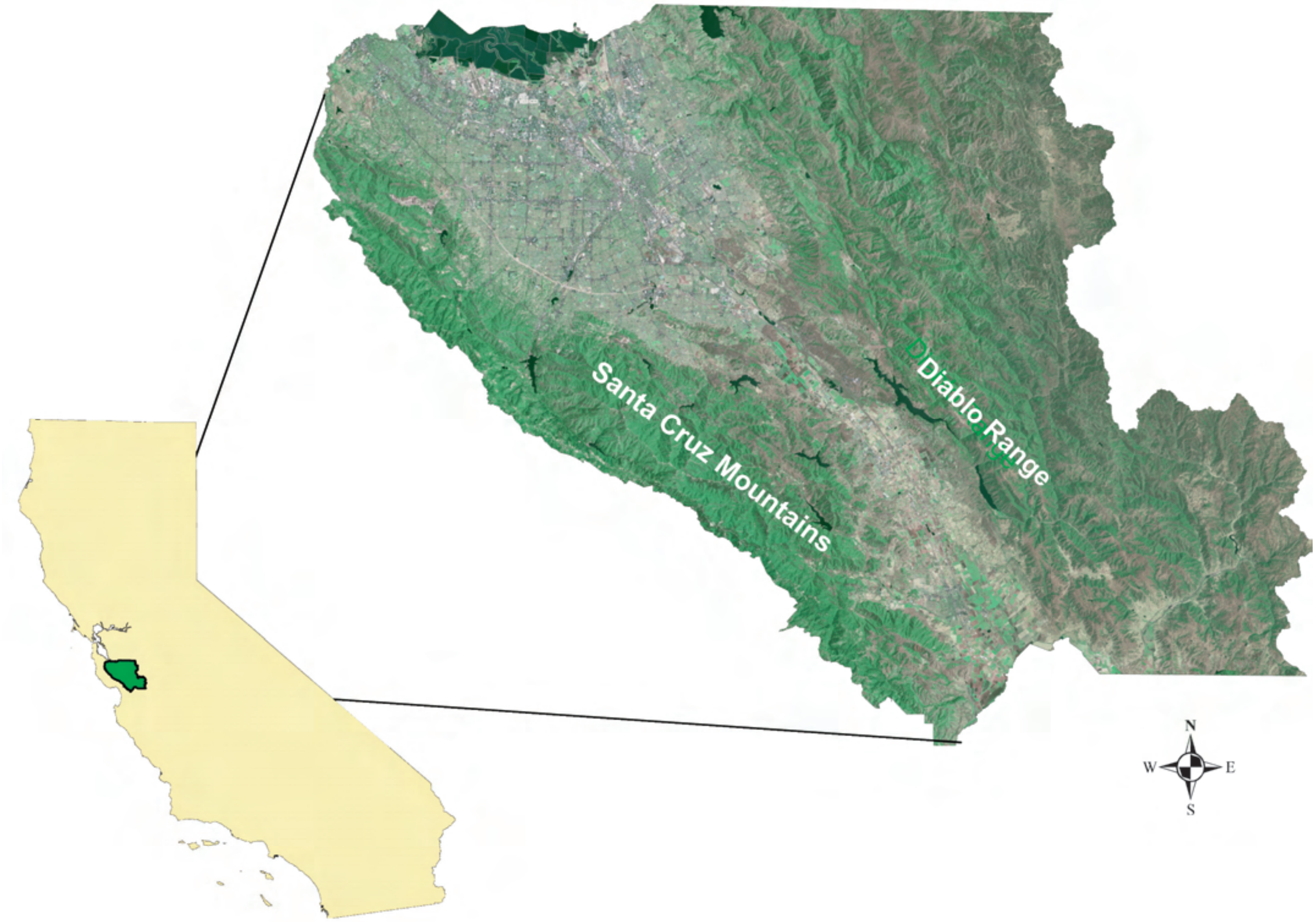
- District efforts to address groundwater quality issues related to the use of recycled water
- Updates on a North County nitrate study
- Groundwater supply updates
- Water supply outlook
- Monitoring well installation at a District fueling facility
- The 2001 Groundwater Conditions Report
- Demonstration of web-based depth-to-water reporting
- Proposed South County monitoring network improvements
- Saltwater intrusion monitoring reports.

In 2003, the District sponsored groundwater subcommittee meetings on January 8, April 2 and July 9. Issues covered during the 2003 meetings included

- Updates on the South County perchlorate response
- Groundwater supply updates
- Recharge updates
- South County groundwater model updates
- Legislation updates
- Water supply outlook
- USGS grant well updates
- Stormwater infiltration updates.

Figure 1-1.

Location of Santa Clara County



Groundwater Supply Management

2.0 Groundwater Supply Management

As the water resource management agency for Santa Clara County, the District provides a reliable supply of high-quality water to thirteen private and public water retailers and to private well owners, serving more than 1.7 million residents in the County. In average years, the District imports approximately 60 percent of the County's water supply from the State Water Project (SWP) and the Federal Central Valley Project (CVP). The City and County of San Francisco sells water to some North County cities through the Hetch Hetchy Project. The remaining water supply demands are met by the groundwater subbasins and local surface water. The District is currently expanding the role of recycled water for irrigation and non-potable uses in accordance with Board Ends Policy; approximately 8,000 acre-feet of recycled water was delivered in 2002 and over 8,800 acre-feet of recycled water was delivered in 2003. To improve supply reliability in dry years, the District banks water in groundwater storage facilities at the Semitropic Water Storage District in Kern County and participates in an imported water exchange program with San Benito County.

The District operates and maintains a Countywide conservation and distribution system to convey untreated surface water to groundwater recharge facilities and treatment plants, and to convey treated water to retailers. This water conservation and distribution system includes local reservoirs designed to capture and store runoff, three water treatment plants, in-stream and off-stream groundwater recharge facilities, and the groundwater subbasins. In 2002, groundwater accounted for approximately 157,800 acre-feet of the total 382,400 acre-feet used in Santa Clara County. In 2003, groundwater accounted for approximately 146,900 acre-feet of the total 365,700 acre-feet used in Santa Clara County.

2.1 Santa Clara County Groundwater Subbasins

Santa Clara County contains three interconnected groundwater subbasins that transmit, filter, and store vast quantities of water. These subbasins are shown in Figure 2-1.

The Santa Clara Valley Subbasin in the northern part of the County extends from Coyote Narrows at Metcalf Road to the County's northern boundary. The subbasin is bound on the east by the Diablo Range and on the west by the Santa Cruz Mountains; these two ranges nearly converge at the Coyote Narrows. The Santa Clara Valley Subbasin is approximately 22 miles long and 15 miles wide, with a surface area of 225 square miles. The southern area and the margins of the subbasin are unconfined areas, or forebay areas, where recharge occurs. An extensive regional aquitard occurs within the northern areas of the subbasin at depths ranging from about 100 feet near the forebay to about 150 to 250 feet in the northern interior portion of the subbasin and beneath San Francisco Bay. The thickness of this regional aquitard varies from about 20 feet to over 100 feet. The general groundwater gradient is from the edges of the subbasin toward San Francisco Bay, or generally in the direction of ground slope (Iwamura and Wilson, 1989).

The Coyote Subbasin extends from Metcalf Road south to Cochrane Road, where it meets the Llagas Subbasin at a prescribed boundary that generally coincides with a groundwater divide. The Coyote Subbasin is approximately 7 miles long and 2 miles wide and has a surface area of approximately 15 square miles. The Coyote Subbasin is generally unconfined and has no significant, laterally extensive clay layers. The Coyote Subbasin generally drains north into the Santa Clara Valley Subbasin.

The Llagas Subbasin extends from Cochrane Road, in Morgan Hill, to the County's southern boundary. The subbasin is hydraulically connected to the Bolsa Subbasin of the Hollister Basin and bounded on the south by a prescribed boundary at the Pajaro River (the Santa Clara - San Benito County line). The Llagas Subbasin is approximately 15 miles long, 3 miles wide along its northern boundary, and 6 miles wide along the Pajaro River. A series of interbedded clay layers form an aquitard, which extends north from the Pajaro River. Recharge occurs in the forebay areas outside the aquitard.

The three subbasins serve multiple functions. They transmit water through the gravelly alluvial fans of streams in the forebay area into the deeper confined aquifer zones of the central part of the valley. They provide natural filtration as water is transmitted into deeper aquifers. The subbasins also have vast storage capacity, providing protection against drought and surface water interruptions.

2.2 Groundwater Production

Excessive use of the Santa Clara Valley Subbasin in the past resulted in severely lowered groundwater elevations and groundwater overdraft that decreased fluid pressures in the aquifer systems and caused significant land subsidence. To protect groundwater resources and maximize water supply reliability, the District now conjunctively manages groundwater and surface water to provide a healthful, clean, reliable, and affordable water supply for Santa Clara County. Groundwater production is now generally balanced by the combination of artificial and natural recharge.

The District records groundwater production and administers well construction and destruction programs to protect the County's groundwater resources by ensuring that wells and other deep excavations are constructed, maintained, and destroyed such that they will not cause groundwater contamination. In 2002, the District issued 2,028 well permits, completed 1,914 well inspections, and destroyed 9 abandoned water wells. In 2003, the District issued 1,994 well permits and completed 1,737 well inspections.

District staff maintains accounts and records for more than 6,000 water production wells and approximately 27,000 monitoring wells. Although approximately half of the production wells within the County are not metered, metered wells produce the vast majority of groundwater used within the County. Where meters are not installed, groundwater production is estimated using efficiency or flow testing, power usage, or crop factors.

In 2002, approximately 104,800 acre-feet of groundwater was extracted from the Santa Clara Valley Subbasin. Almost all of the Santa Clara Valley Subbasin groundwater was used for municipal and industrial (M&I) uses (104,100 acre-feet), with approximately 700 acre-feet used for agriculture. It is estimated that 53,000 acre-feet of groundwater was extracted from the Coyote and Llagas Subbasins, which includes approximately 25,500 acre-feet for M&I uses and 27,500 acre-feet for agriculture. The total amount of groundwater extracted in 2002 (157,800 acre-feet) is a decrease of about 11,500 acre-feet from the 169,300 acre-feet pumped in 2001.

In 2003, approximately 96,600 acre-feet of groundwater was extracted from the Santa Clara Valley Subbasin. Almost all of this water was for M&I uses (96,200 acre-feet), with approximately 400 acre-feet used for agriculture. It is estimated that 50,300 acre-feet of groundwater was extracted from the Coyote and Llagas Subbasins, which includes approximately 24,300 acre-feet for M&I uses and 26,000 acre-feet for agriculture. The total amount of groundwater extracted in 2003 (146,900 acre-feet) is a decrease of about 11,000 acre-feet from the 157,800 acre-feet pumped in 2002; see Table 2-1 for a summary of groundwater production since 1981.

Groundwater Supply Management

2.3 Groundwater Recharge

To offset groundwater production and to ensure the long-term sustainability of groundwater resources, the District conducts a conjunctive use program whereby local and imported surface waters are used to replenish the groundwater subbasins through District facilities. Groundwater is also replenished by natural recharge.

2.3.1 Artificial Recharge

To help balance groundwater extraction, the District conducts recharge operations along streams and in off-stream ponds. In-stream recharge occurs along about 70 miles of stream channels in the alluvial plain, upstream of the confined zone (Figure 2-2). Off-stream facilities include 71 ponds ranging in size from less than 1 acre to more than 20 acres. By releasing locally conserved and imported waters from local reservoirs or the distribution system, the District significantly increases the recharge that would occur within these streams and ponds. Figure 2-2 shows the location of the District's percolation ponds; each symbol represents a group of ponds at each location. The Operations Planning and Analysis Unit produces an annual Operations Report to plan for the distribution of water supplies to treatment plants and to recharge operations. Through both in-stream and off-stream artificial recharge operations, approximately 107,300 acre-feet of water recharged the groundwater subbasins in 2002, and approximately 118,100 acre-feet of water recharged the groundwater suubasins in 2003.

In 2002, approximately 72,000 acre-feet of water was recharged in the Santa Clara Valley Subbasin through artificial recharge operations; including 44,900 acre-feet through the in-stream recharge program and 27,100 acre-feet recharged through off-stream ponds. Approximately 35,300 acre-feet of water was recharged in the Coyote and Llagas Subbasins through artificial recharge operations, including 28,900 acre-feet through in-stream recharge and 6,400 acre-feet through off-stream ponds.

In 2003, approximately 74,800 acre-feet of water recharged the Santa Clara Valley Subbasin through artificial recharge operations; this included 38,400 acre-feet through the in-stream recharge program and 36,400 acre-feet recharged through off-stream ponds. Approximately 43,400 acre-feet of water recharged the Coyote and Llagas Subbasins through artificial recharge operations, including 38,900 acre-feet through in-stream recharge and 4,500 acre-feet through off-stream ponds.

The District is currently evaluating in-stream recharge facilities future operations. Temporary gravel dam operations have generally been discontinued throughout the County. As a result of environmental concerns regarding endangered fisheries, the District has been participating in the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE).

In May, 2003, the District completed negotiations on a draft settlement agreement in the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE). This draft settlement agreement provides a framework for making future water supply operations decisions in the Stevens Creek, Guadalupe and Coyote watersheds. The draft agreement includes new fisheries management strategies as well as reservoir rule curves that will govern day to day operations within the three watersheds. Recharge operations along Stevens Creek, Guadalupe Creek, and Coyote Creek will be modified to improve fisheries habitat under the draft settlement. The draft settlement does not preclude in-stream recharge in many reaches of the three watersheds. Environmental documentation (CEQA/NEPA) is currently being prepared for the draft settlement agreement as well as a "limited-effects" Habitat Conservation Plan. It is anticipated that the draft settlement agreement will be finalized within the next 2 years.

To ensure that District groundwater management programs designed to replenish the subbasins and to protect groundwater resources are effective, the District maintains rigorous monitoring networks to track groundwater elevations, groundwater quality, and land subsidence. These programs and the 2002 and 2003 monitoring results are summarized later in this report.

2.3.2 Natural Recharge

Sources of natural recharge include rainfall, recharge from uncontrolled streams, seepage from surrounding hills, seepage between groundwater subbasins, net irrigation return flows, and incidental recharge. The main source of natural recharge to the groundwater subbasins is the deep percolation of precipitation. Valley portions of Santa Clara County may be categorized as having a semi-arid climate. The average rainfall in San Jose is 14.45 inches, based on 129 years of record (Figure 2-3). Typically, 90 percent of rainfall occurs between November and April. The months between May and October are consistently dry and make up the remaining 10 percent of the rainfall year total. For San Jose, January is the wettest month with an average of 2.88 inches rainfall and July is the driest with an average of 0.02 inches. The 2002 rainfall year total (from July 1, 2001 through June 30, 2002) recorded at the San Jose Station was 11.06 inches, which is 78 percent of normal. The 2003 rainfall total (from July 1, 2002 through June 30, 2003) recorded at the San Jose Station was 15.33 inches, which is 106 percent of normal.

As can be seen from Figure 2-3, since the period of record began in 1874, Santa Clara County has experienced several relatively wet periods in addition to extended periods of below average rainfall. Severe, short-term droughts, such as those that occurred in 1877 and 1976-77, are also evident from the rainfall record.

Since many of the components of deep percolation can not be directly measured, natural recharge is estimated and irrigation return flows recharge the subbasins along with rainfall, however these cannot be directly measured.

Estimates of Natural Recharge

The groundwater flow model can be used to estimate the natural recharge to the primary water supply aquifers of the Santa Clara Valley Subbasin. The groundwater model calculated that the Santa Clara Valley Subbasin natural recharge was approximately 28,800 acre-feet for 2002 and approximately 29,400 acre feet in 2003.

The natural recharge for the Coyote and Llagas Subbasins has historically been estimated according to the following equation:

[Natural Recharge + Artificial Recharge] –
[Groundwater Pumping] = Change in Storage

The District measures artificial recharge and groundwater pumping and estimates the change in storage for South County by using groundwater elevation contour maps. Natural recharge is then back-calculated using the equation above. There are several limitations to this analysis. First, the accuracy of the estimate is limited by the lack of a dynamic groundwater flow model capable of simulating changes in groundwater elevation with varying pumping and recharge conditions. Second, there is uncertainty in several of the terms in the equation above. For instance, the majority of wells in South County do not have meters; groundwater pumping is estimated as described in Section 2.2. Third, the change in storage term is estimated based on groundwater contours interpolated from a relatively sparse distribution of monitoring wells. Given these limitations, there is insufficient data to estimate South

County natural recharge at this time. Development of a groundwater flow model for the Llagas Subbasin began in December 2003 and was completed in 2004. This model is expected to improve the District's ability to estimate natural recharge.

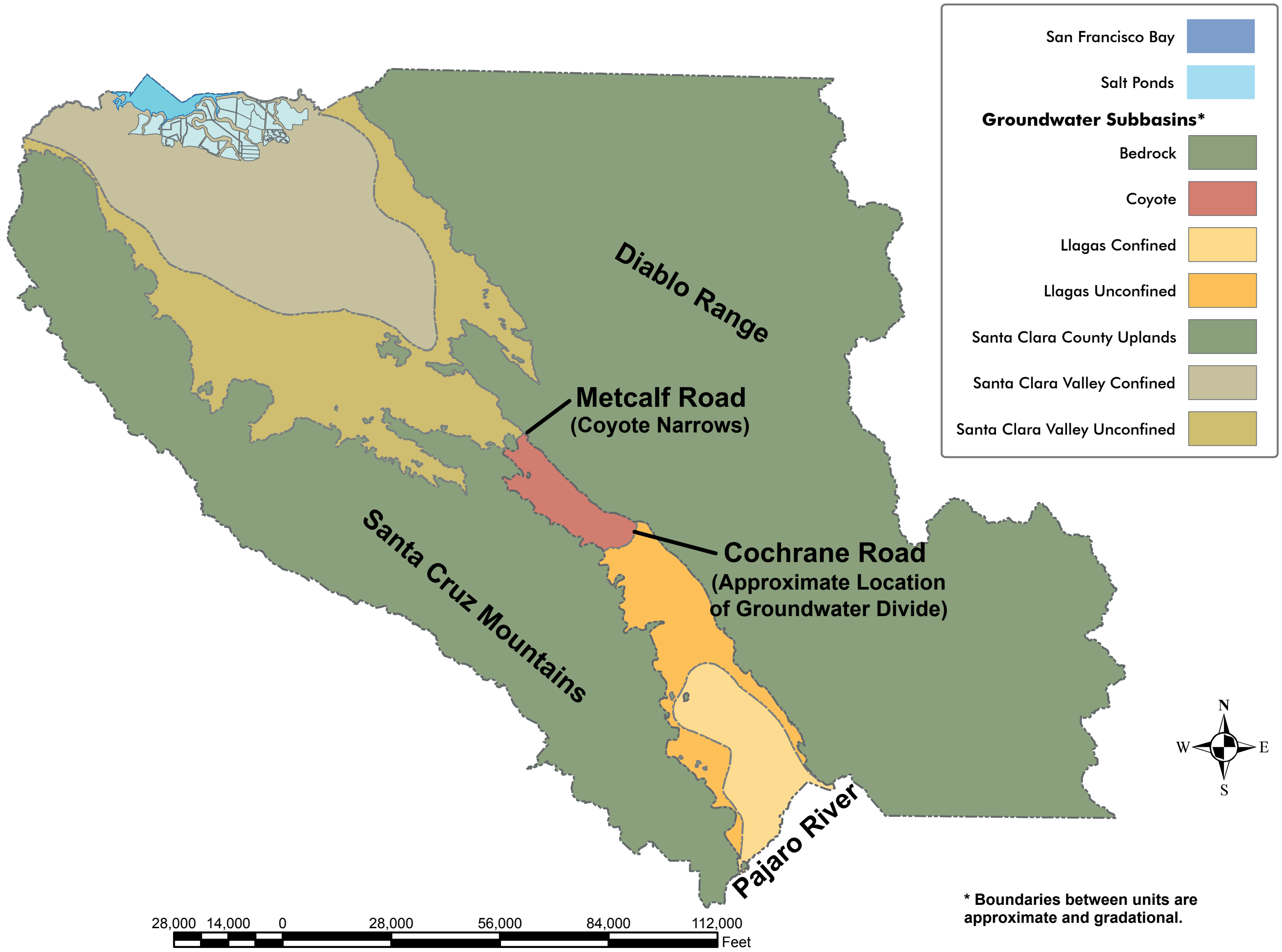
Table 2-1
Groundwater Production Summary

	Santa Clara Valley Subbasin			Coyote and Llagas Subbasins[1]			
Calendar Year	Ag (ac-ft)	M&I (ac-ft)	Total (ac-ft)	Ag (ac-ft)	M&I (ac-ft)	Total (ac-ft)	Total District Production (ac-ft)
1981	8,600	151,300	159,900	-	-	-	-
1982	6,300	135,000	141,300	-	-	-	-
1983	5,600	147,100	152,700	-	-	-	-
1984	6,300	172,300	178,600	-	-	-	-
1985	6,200	174,900	181,100	-	-	-	-
1986	5,500	168,700	174,200	-	-	-	-
1987	5,900	165,600	171,500	-	-	-	-
1988	5,500	150,300	155,800	25,000	20,900	45,900	201,700
1989	4,800	84,000	88,800	24,400	17,100	41,500	130,300
1990	4,800	101,900	106,700	24,900	17,700	42,600	149,300
1991	3,800	88,400	92,200	28,300	16,900	45,200	137,400
1992	3,500	103,700	107,200	30,100	17,500	47,600	154,800
1993	3,100	101,900	105,000	27,800	18,200	46,000	151,000
1994	3,000	120,000	123,000	30,400	18,900	49,300	172,300
1995	2,500	110,100	112,600	29,100	19,200	48,300	160,900
1996	2,600	109,900	112,500	29,900	19,700	49,600	162,100
1997	1,900	118,500	120,400	32,800	21,700	54,500	174,900
1998	1,100	99,200	100,300	25,800	20,000	45,800	146,100
1999	1,100	106,400	107,500	29,100	23,800	52,900	160,400
2000	1,000	111,500	112,500	26,900	24,500	51,400	163,900
2001	800	114,600	115,400	28,500	25,400	53,900	169,300
2002	700	104,100	104,800	27,500	25,500	53,000	157,800
2003	400	96,200	96,600	26,000	24,300	50,300	146,900

[1] District assumed management of South County subbasins in 1987. No earlier groundwater production data is available.

Figure 2-1

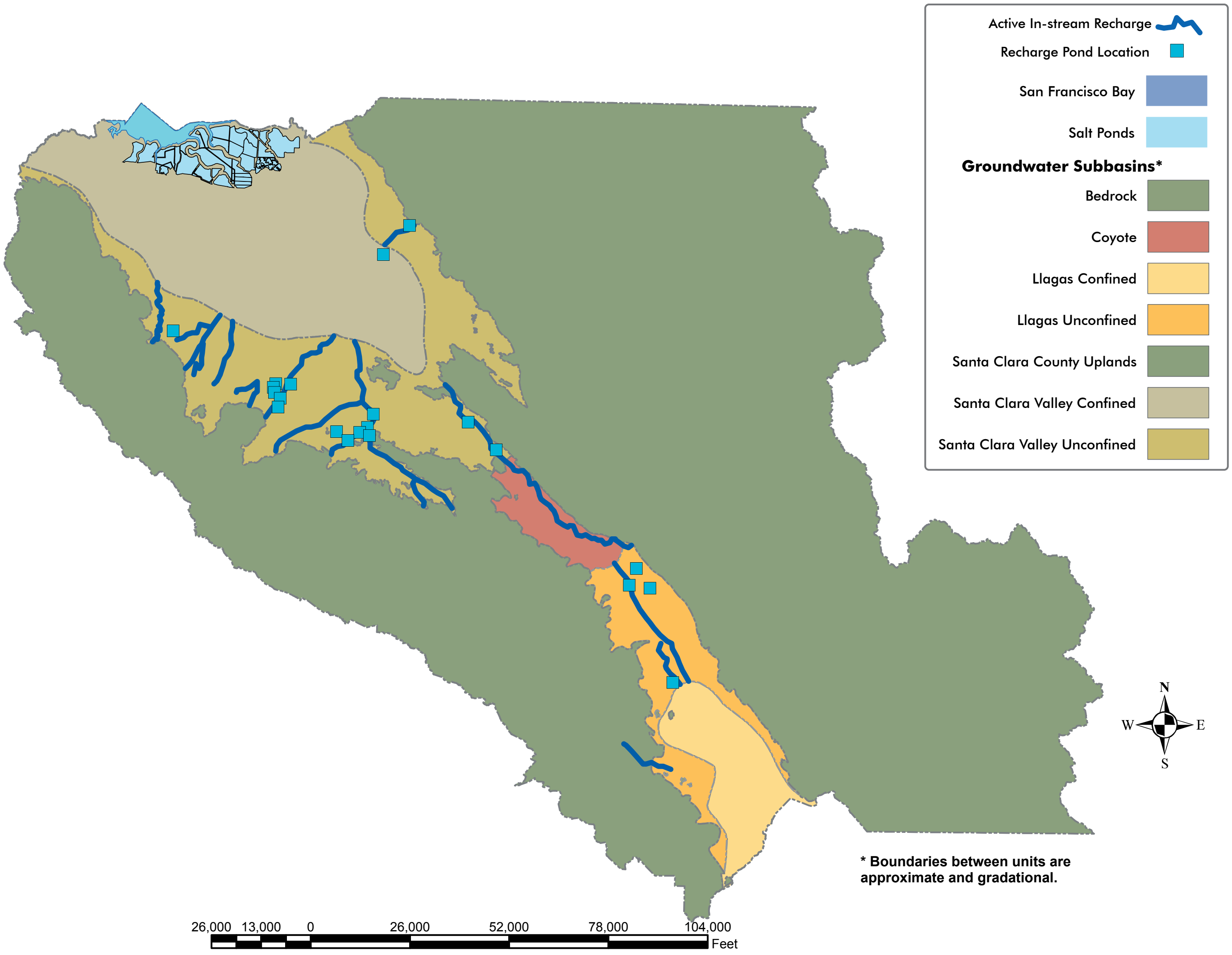
Santa Clara County Groundwater Subbasins



* Boundaries between units are approximate and gradational.

Figure 2-2

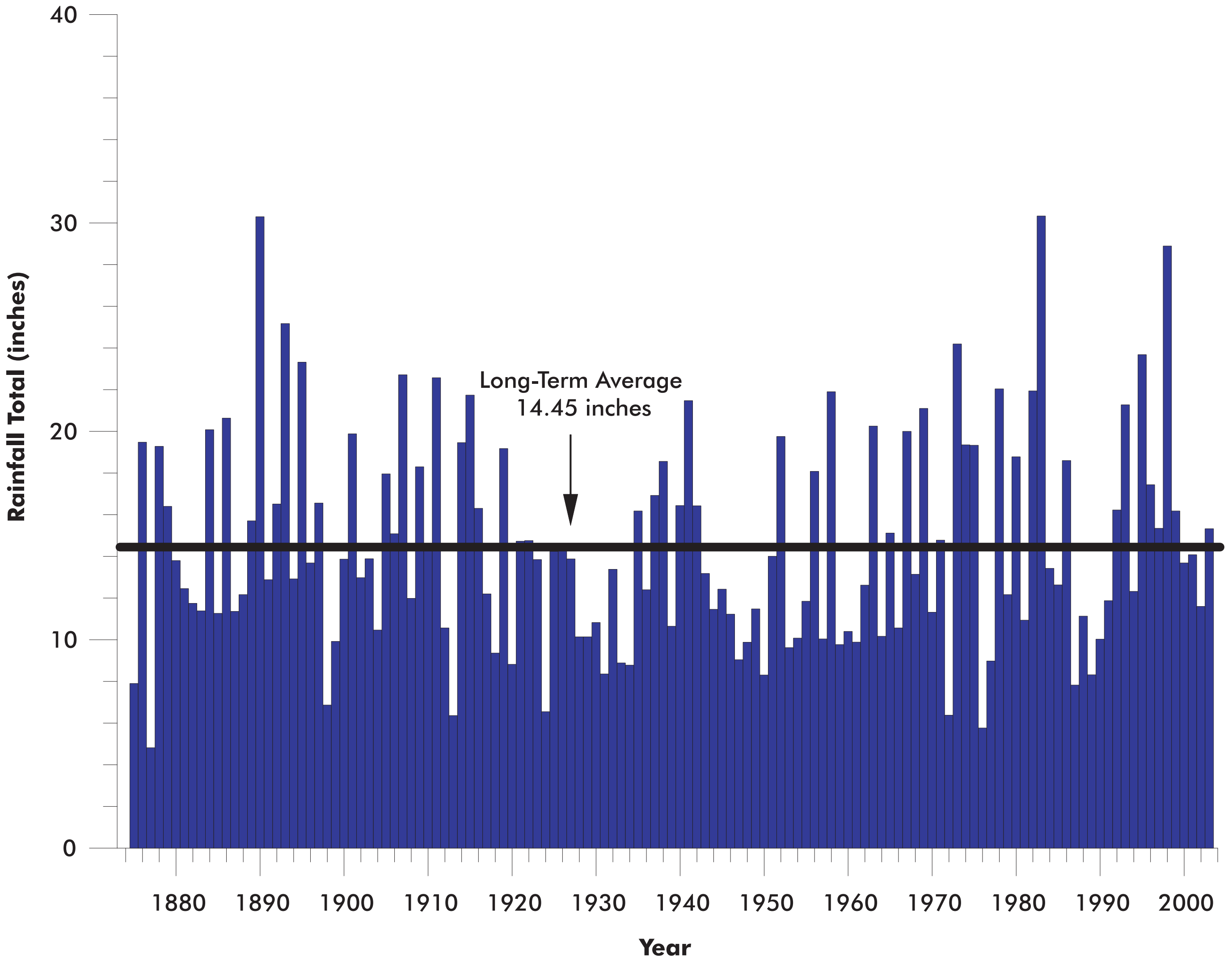
District In-Stream and Off-Stream Recharge Facilities



* Boundaries between units are approximate and gradational.

Figure 2-3

Total Annual Rainfall at San Jose Station (Rainfall Years)



Groundwater Elevation Monitoring

3.0 Groundwater Elevation Monitoring

Groundwater elevations are affected by natural and artificial recharge and groundwater extraction, and are indicators of how much groundwater is in storage at a particular time. Both low and high elevations can cause adverse conditions. Low groundwater levels can lead to land subsidence and high groundwater levels can lead to nuisance conditions for below-ground structures and may necessitate dewatering.

The District has been collecting groundwater elevation data since it was first formed as a conservation district in 1929. Groundwater elevation data are used to evaluate current groundwater resource conditions, to optimize recharge efforts, to assess groundwater storage, and to support modeling efforts. The District provides groundwater elevation data and other information to consultants, other agencies and the public as requested. Through frequent monitoring of groundwater elevations, the District evaluates groundwater supply conditions and formulates strategies to manage the groundwater basin.

The District collects groundwater elevation measurements for approximately 260 wells. Most wells in the program are privately owned and their locations are fairly evenly distributed among the three groundwater subbasins (Figure 3-1). Although the District collects groundwater elevation data from many wells throughout the County, most wells were designed as production wells with perforations across multiple aquifers to increase groundwater production. In wells with perforations across multiple aquifers, measured groundwater elevations represent a composite of the elevations across the aquifers. There are relatively few wells that measure groundwater elevations in a single aquifer.

In 2002 and 2003, the District collected or received groundwater elevation data for approximately 259 wells. 122 of these were measured monthly, while the remaining 137 were measured on a quarterly basis (Figure 3-1). Although many of the monitoring wells are production wells, the District makes every effort to measure only static groundwater elevations. Among the data collected were monthly elevation data for "index wells" for each of the valley's three groundwater subbasins. These index wells have been chosen because they are considered to be representative of general groundwater elevation trends within each subbasin. Figure 3-1 shows the location of the index wells in each subbasin.

All groundwater elevation data are maintained in the District's Groundwater Monitoring database. Summaries of groundwater elevation monitoring results for each subbasin are presented below.

3.1 Santa Clara Valley Subbasin

Groundwater elevations for the Santa Clara Valley Subbasin index well through 2003 are shown in Figure 3-2. The period of record begins in 1915, which marks the beginning of a steady 20-year decline in groundwater levels and coincides with a period when rainfall was generally below average and there was agricultural overdraft (see Figure 3-2). In 1935 and 1936 the District completed six water conservation reservoirs. This additional local storage, coupled with an above-average period of rainfall, resulted in an increase in groundwater levels which continued until the early 1940s. Following this abbreviated period of groundwater rise, a long period of decline commenced until the lowest groundwater level of record was reached in October of 1964. The 1945 to 1968 period of groundwater level decline was due largely to a period of below-average rainfall and increasing water demand as a result of post-WWII development and population growth. In 1965 the District began receiving the first deliveries of imported water through

Bay Aqueduct (SBA), part of the State Water Project. Since the introduction of SBA water, groundwater levels have generally increased, with the exception of two significant drought periods beginning in 1977 and 1987 (Figure 3-2).

The 2002 groundwater elevations in the Santa Clara Valley Subbasin index well are approximately 28 feet below the historic maximum level of 116.4 feet above MSL (Mean Sea Level) in 1916 and are more than 200 feet above the minimum groundwater level for the period of record. Additionally, the minimum 2002 groundwater elevation recorded in the fall is approximately 63 feet above the subsidence threshold for this area. Subsidence thresholds, groundwater elevations below which significant subsidence will occur, are discussed in detail in Section 4.0. In general, groundwater elevations throughout the subbasin were relatively high in 2002.

The 2003 groundwater elevations in the Santa Clara Valley Subbasin index well are approximately 19 feet below the historic maximum level of 116.4 feet above MSL in 1916 and show a recovery of 213 feet from the minimum groundwater level for the period of record. The minimum 2003 groundwater elevation recorded in the fall is approximately 70 feet above the subsidence threshold for this area. Groundwater elevations throughout the subbasin were relatively high in 2003.

Groundwater elevations in the Santa Clara Valley Subbasin index well are used to measure District performance in meeting the Board Ends Policy which directs staff to ensure "Groundwater supplies are sustained." Groundwater levels and storage in the Santa Clara Valley Subbasin in 2002 and 2003 were near historical high levels and were well above the subsidence threshold for that region.

To provide a regional view of 2002 and 2003 groundwater elevations in the Santa Clara Valley Subbasin, contour maps were produced. It should be noted that contour maps for the Santa Clara Valley Subbasin are fairly difficult to interpret simply by contouring groundwater elevation data from wells. As the majority of wells are screened in multiple zones, interpretation of data from the wells produces a contour map that represents composite groundwater elevations from different water bearing zones. Therefore, spring and fall 2002 and 2003 groundwater elevations are computed by the North County groundwater model, see Figures 3-3 through 3-6. These elevations are associated with a specific model layer that represents the primary water supply aquifers. In general, groundwater elevations in the Santa Clara Valley Subbasin did not change significantly between spring and fall of 2002 and 2003.

3.2 Coyote Subbasin

General groundwater elevations in the Coyote Subbasin are represented by three index wells (Figure 3-7). Minimum groundwater levels for the period of record for all three Coyote Subbasin index wells were recorded in the late 1940s. The maximum groundwater levels for the period of record occurred in 1983 at all three index wells. From the late 1940's, groundwater elevations in index wells 09S02E02J002 and 09S02E12E001 exhibit a gradual increase in groundwater elevation with time. The hydrograph for index well 09S03E16C001, which is located near the border of the Coyote and Llagas Subbasins, does not show the same general increasing trend in groundwater elevations, and appears to reflect more seasonality. Water levels in well 09S03E16C001 are likely influenced by pumping from nearby water supply wells.

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[1] Elevations are referenced to the National Vertical Geodetic Datum 1929, feet.

Groundwater Elevation Monitoring

Throughout 2002, groundwater elevations were at least 30 feet above minimum levels recorded in the late 1940s and at least 15 feet below the maximum levels recorded in 1983. Throughout 2003, groundwater elevations were at least 34 feet above minimum levels and at least 13 feet below the maximum levels recorded in 1983. No subsidence threshold level has been established for the Coyote Subbasin because the subsurface sediments of the subbasin are not prone to subsidence. Sufficient confining clay layers which cause subsidence are not present in the Coyote Subbasin.

General groundwater elevation conditions for the Coyote Subbasin are shown on contour maps showing lines of equal groundwater elevation for spring and fall 2002 and 2003 (Figures 3-8 through 3-11). Data from 49 wells were used to construct these contour maps. These maps show a fairly significant decline in groundwater elevations between the spring and fall. The seasonal decline corresponds to the agricultural irrigation season and increased summer water use. Groundwater elevations increase in the winter, when most irrigation stops and the rainy season begins.

3.3 Llagas Subbasin

The hydrograph for the Llagas Subbasin index well is shown in Figure 3-12. The effects of the 1977 and 1987 droughts are clearly indicated by pronounced declines in groundwater elevations in the index well. In the 30-year period of record, the minimum groundwater elevation was recorded in the fall of 1977 and the maximum groundwater elevation was recorded in the spring of 1998. 2002 groundwater levels were approximately 19 feet below the maximum and approximately 59 feet above the minimum groundwater elevations recorded for the period of record. 2003 groundwater levels were approximately 15 feet below the maximum and approximately 67 feet above the minimum groundwater elevations recorded for the period of record.

Groundwater elevations in the Llagas Subbasin index well are also used to measure District performance in meeting the Board Ends Policy which directs staff to ensure “Groundwater supplies are sustained.” The target level for the Llagas Subbasin corresponds to the minimum groundwater elevation recorded during 1987 in the index well, the year the District assumed management of South County from the Gavilan Water District. Although annual water levels and storage in the Llagas Subbasin have decreased since the late 1990s, groundwater elevations remain above the target level.

General groundwater elevation conditions for the Llagas Subbasin can be seen on contour maps showing lines of equal groundwater elevation for spring and fall 2002 and 2003 (Figures 3-8 through 3-11). These maps show a fairly significant decline in groundwater elevations between spring and fall, particularly in the Llagas Subbasin. As noted above, this decline is an annual seasonal phenomenon that corresponds to the agricultural irrigation season and increased summer water use.

3.4 Change in Storage

Groundwater is constantly changing; it enters a groundwater subbasin through natural or artificial recharge and leaves the subbasin through production wells or subsurface flow. If the volume of groundwater leaving and entering the subbasin is balanced, the subbasin is in a steady state condition and there is no change in storage. If more groundwater is leaving the subbasin than is entering, the amount of groundwater in storage is decreased. The opposite is true for a net increase in storage; that is, more groundwater enters the subbasin than exits.

3.4.1 North County

In the Santa Clara Valley Subbasin, the change in storage is estimated using the groundwater flow model. Using this method, it is estimated that groundwater storage increased in 2002 by approximately 11,000 acre-feet to 13,000 acre-feet, and increased by approximately 15,000 to 17,000 acre-feet in 2003. Figure 3-13 shows the annual change in storage in the Santa Clara Valley Subbasin since 1993. The model results indicate that between 1993 and 2003, the groundwater resource is increasing.

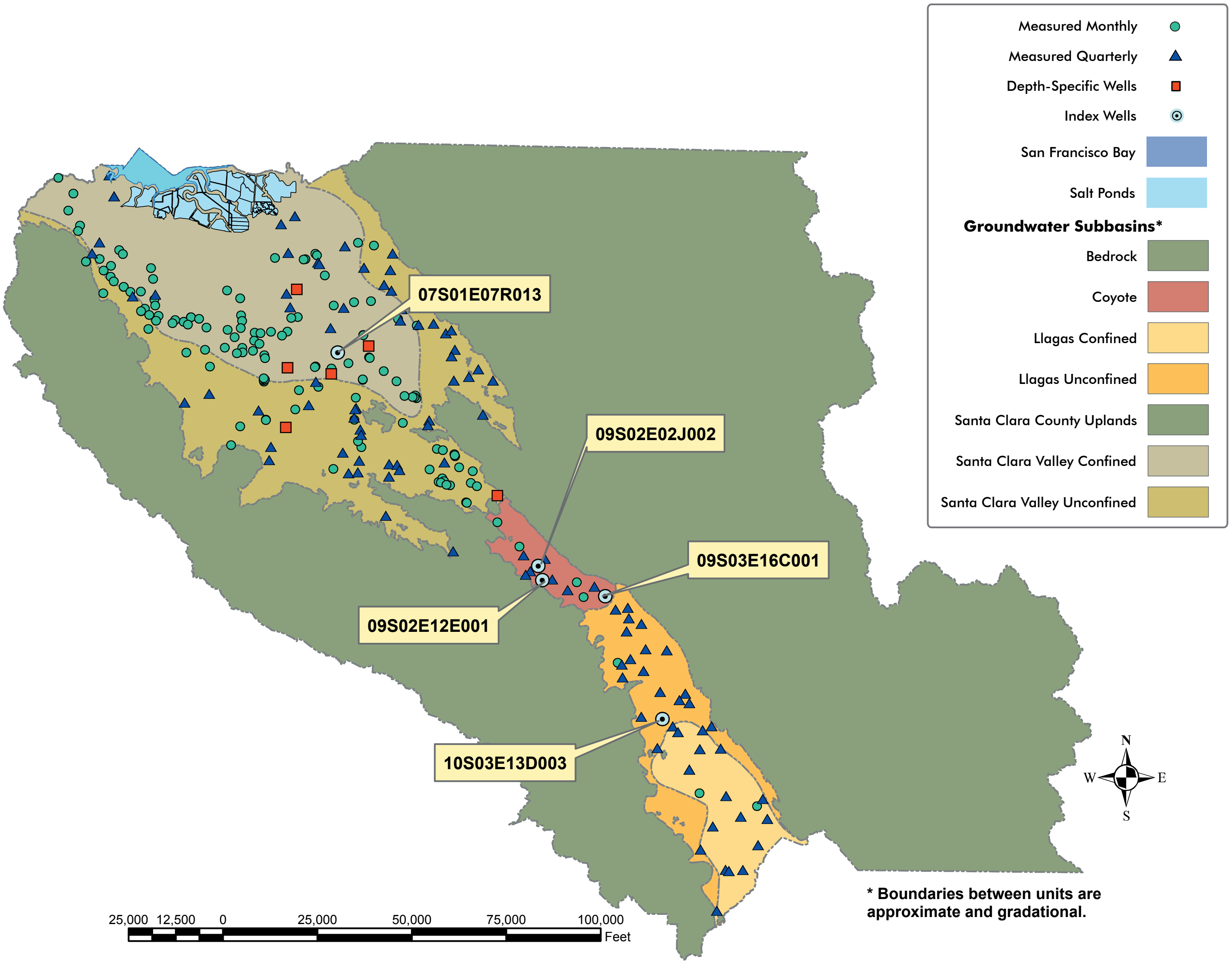
3.4.2 South County

The South County groundwater flow model was under development and was not available for 2002 and 2003 change in storage calculations for South County. For 2002 and 2003, the change in storage was calculated using groundwater elevation contour maps. The subbasins are divided into “cells” and the difference in groundwater elevation from fall to fall of consecutive years is determined for each cell using the contour maps. This difference is then multiplied by a generalized storage coefficient and area for each cell to determine the change in storage for the Coyote and Llagas Subbasins. Using this method in 2002, it is estimated that the volume in storage decreased in the Coyote and Llagas Subbasins by approximately 15,000 to 17,000 acre-feet. In 2003, the volume in storage increased in the Coyote and Llagas Subbasins by approximately 13,000 to 15,000 acre-feet. Figure 3-14 shows the annual change in storage for the Coyote and Llagas Subbasins since 1988.

Groundwater Elevation Monitoring

Figure 3-1

Groundwater Elevation Monitoring Wells



* Boundaries between units are approximate and gradational.

Figure 3-2
Hydrograph for the Santa Clara Valley Subbasin Index Well (07S01E07R013)

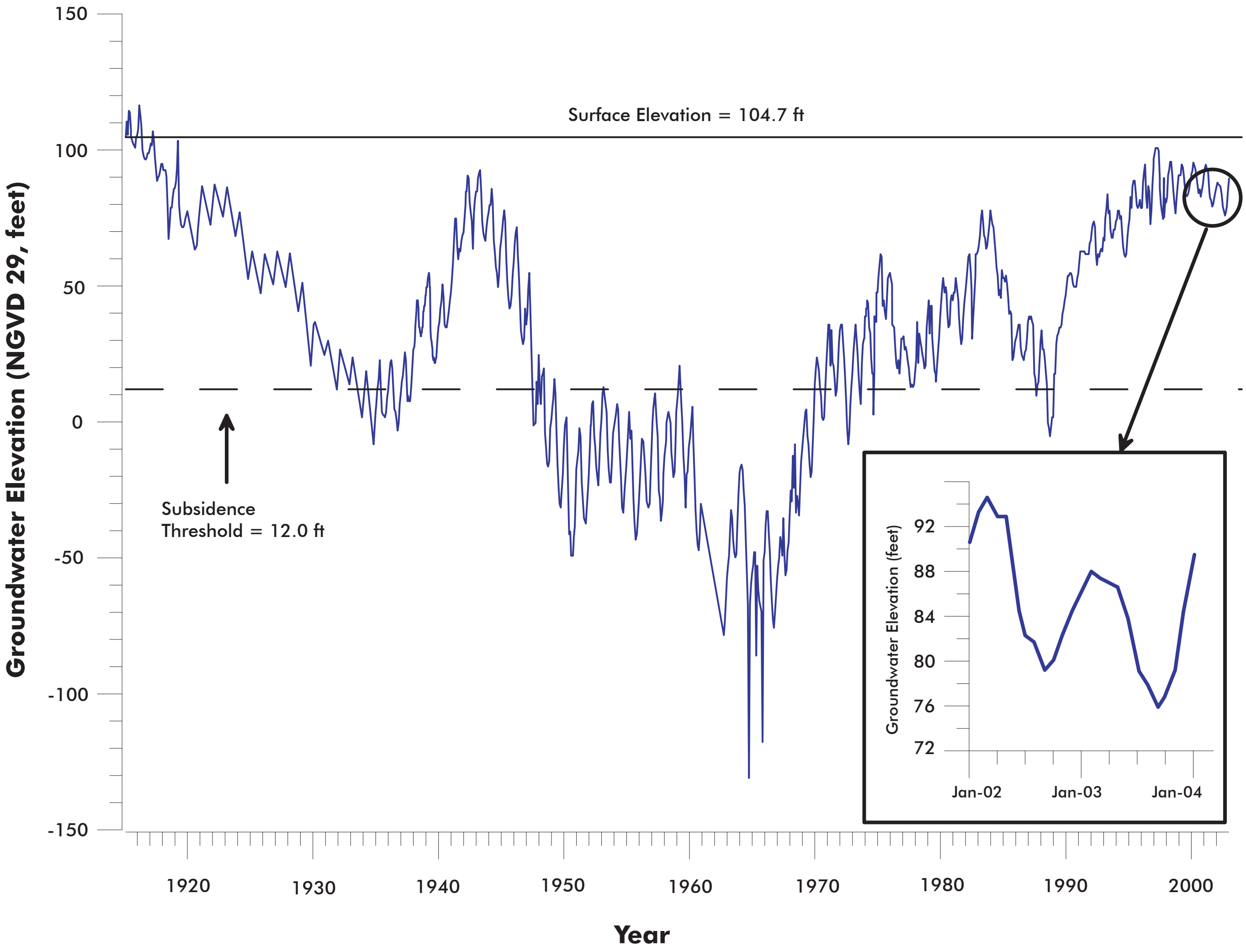
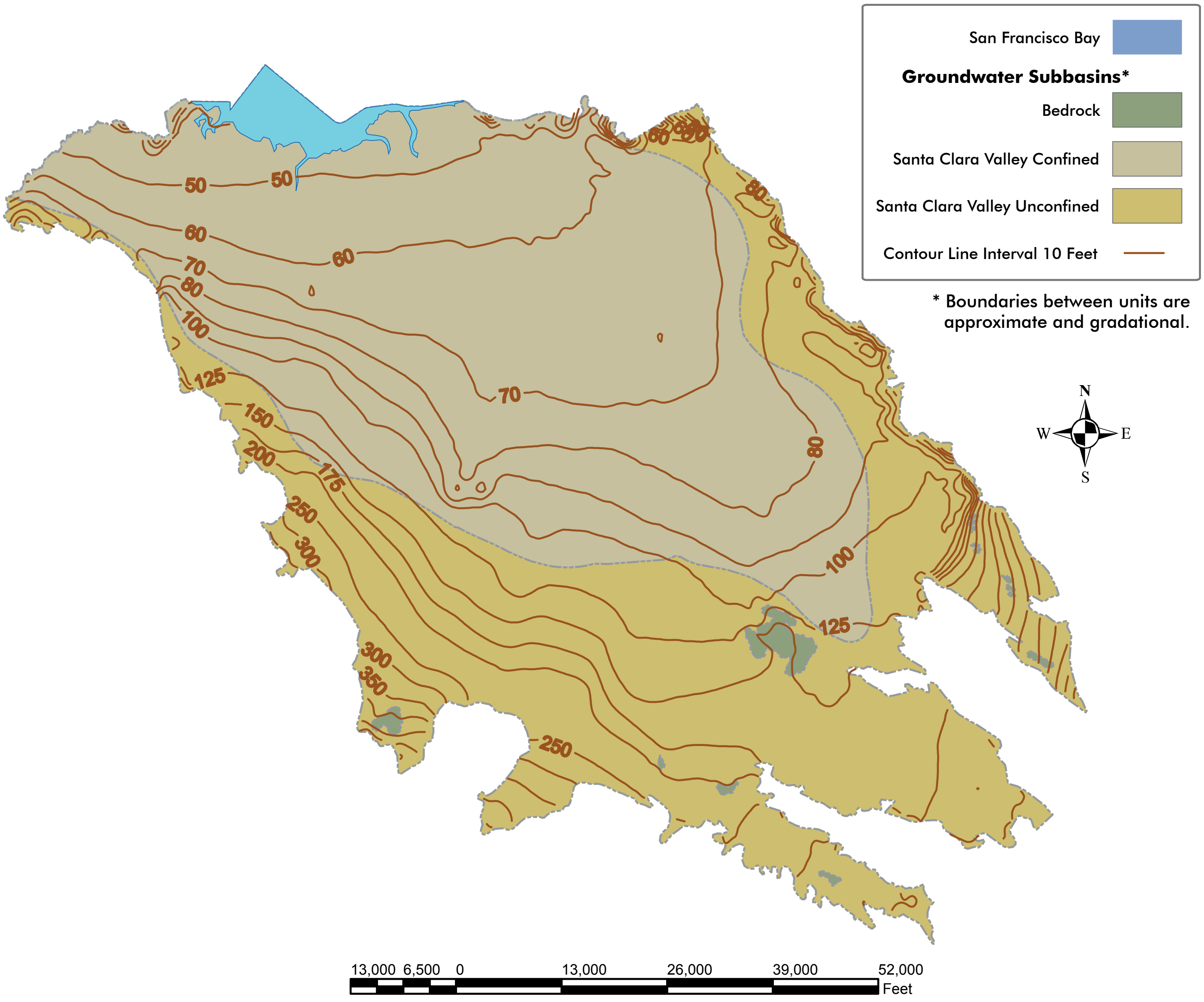


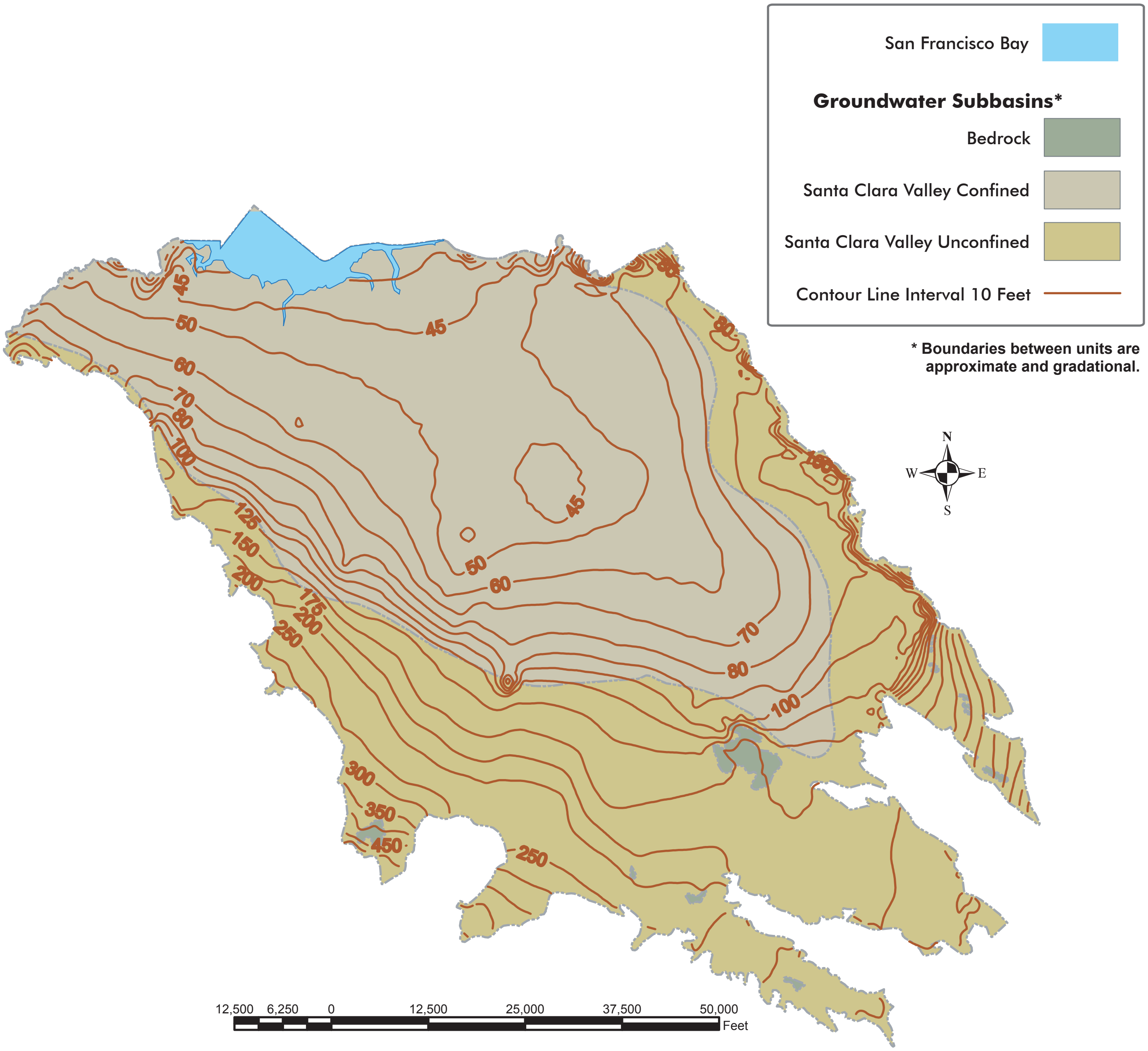
Figure 3-3
North County Groundwater Elevation Contour Map - Spring 2002



* Boundaries between units are approximate and gradational.

Figure 3-4

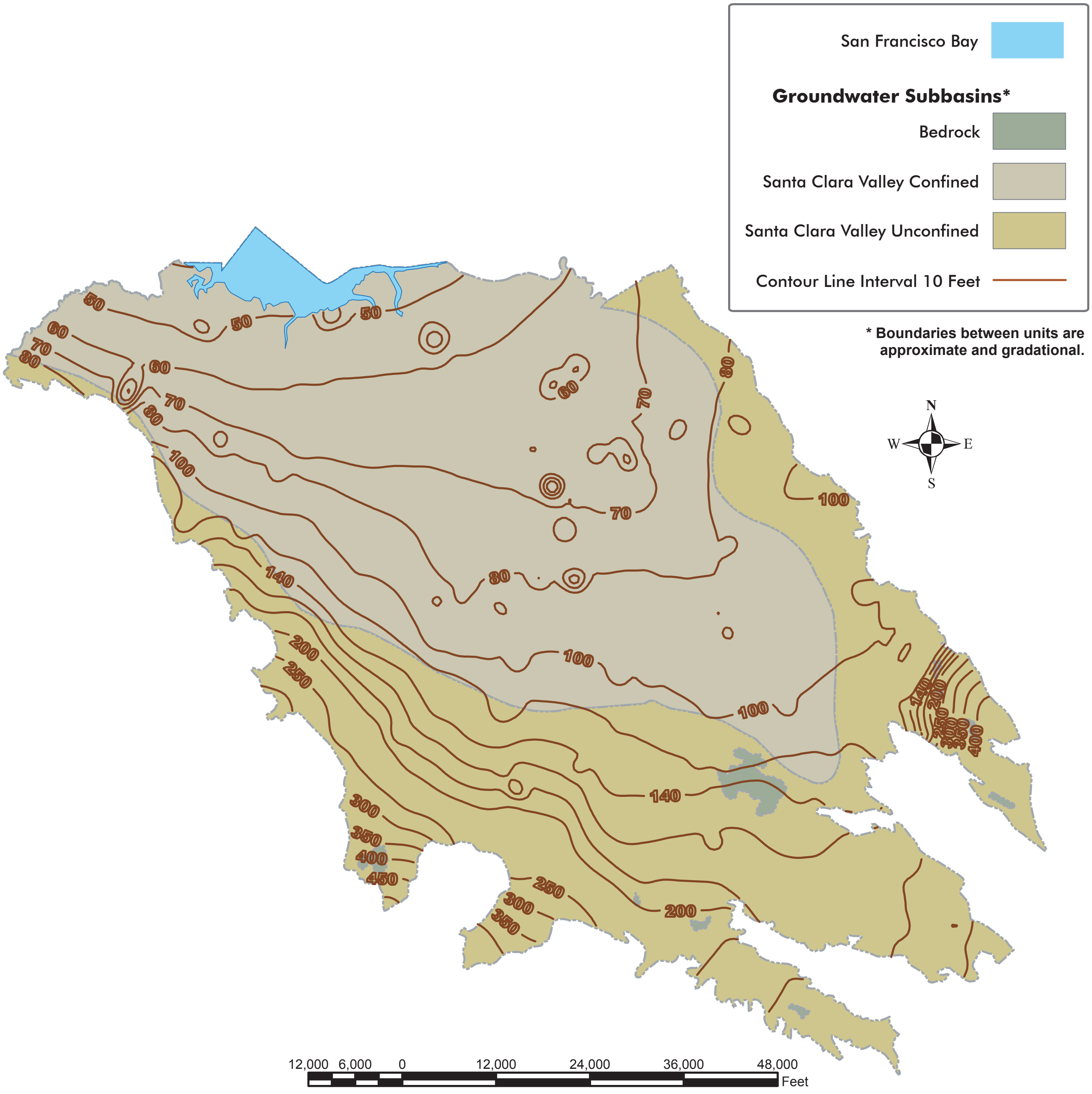
North County Groundwater Elevation Contour Map - Fall 2002



* Boundaries between units are approximate and gradational.

Figure 3-5

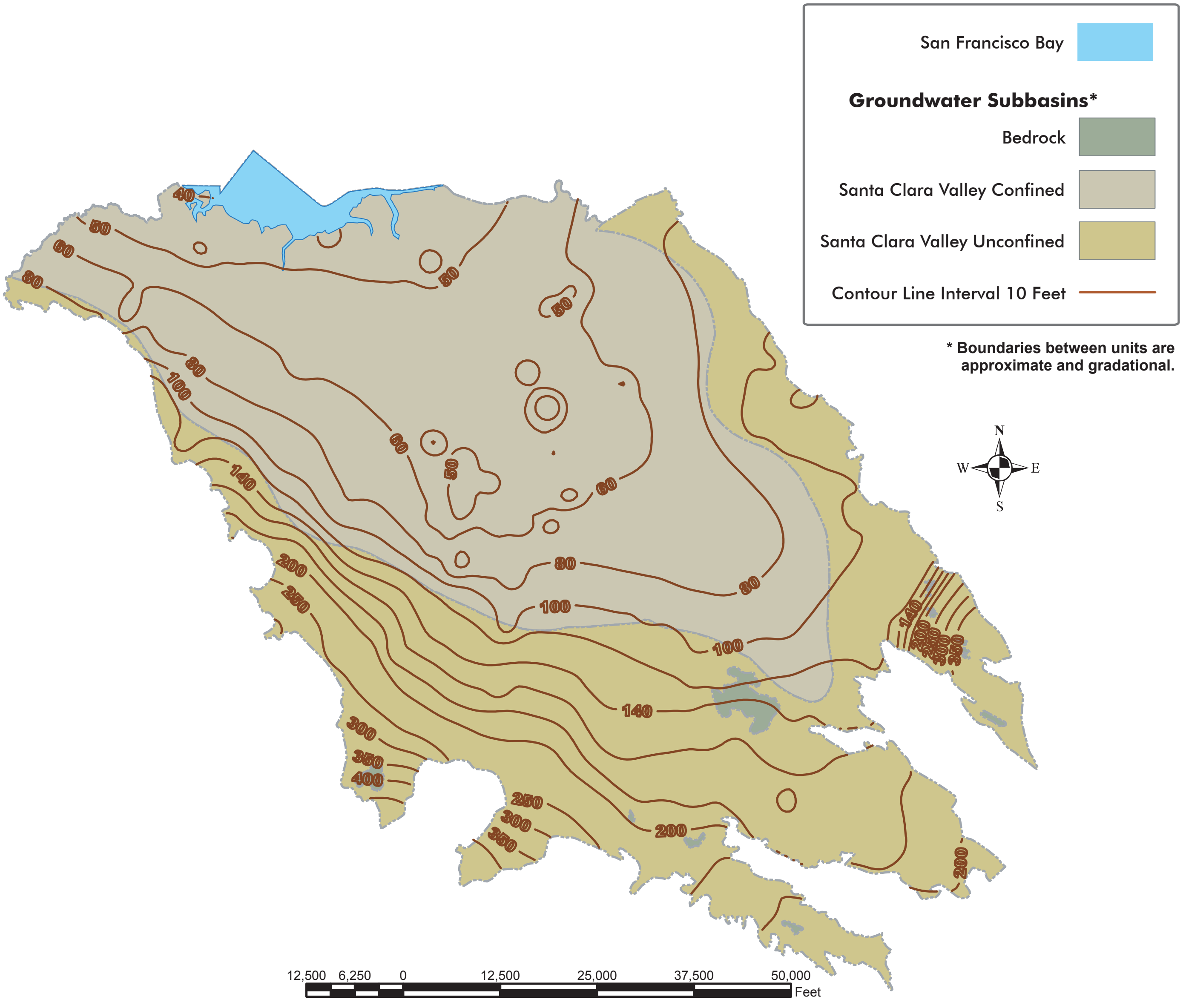
North County Groundwater Elevation Contour Map - Spring 2003



* Boundaries between units are approximate and gradational.

Figure 3-6

North County Groundwater Elevation Contour Map - Fall 2003



Groundwater Elevation Monitoring

Figure 3-7

Hydrograph for the Coyote Subbasin Index Wells

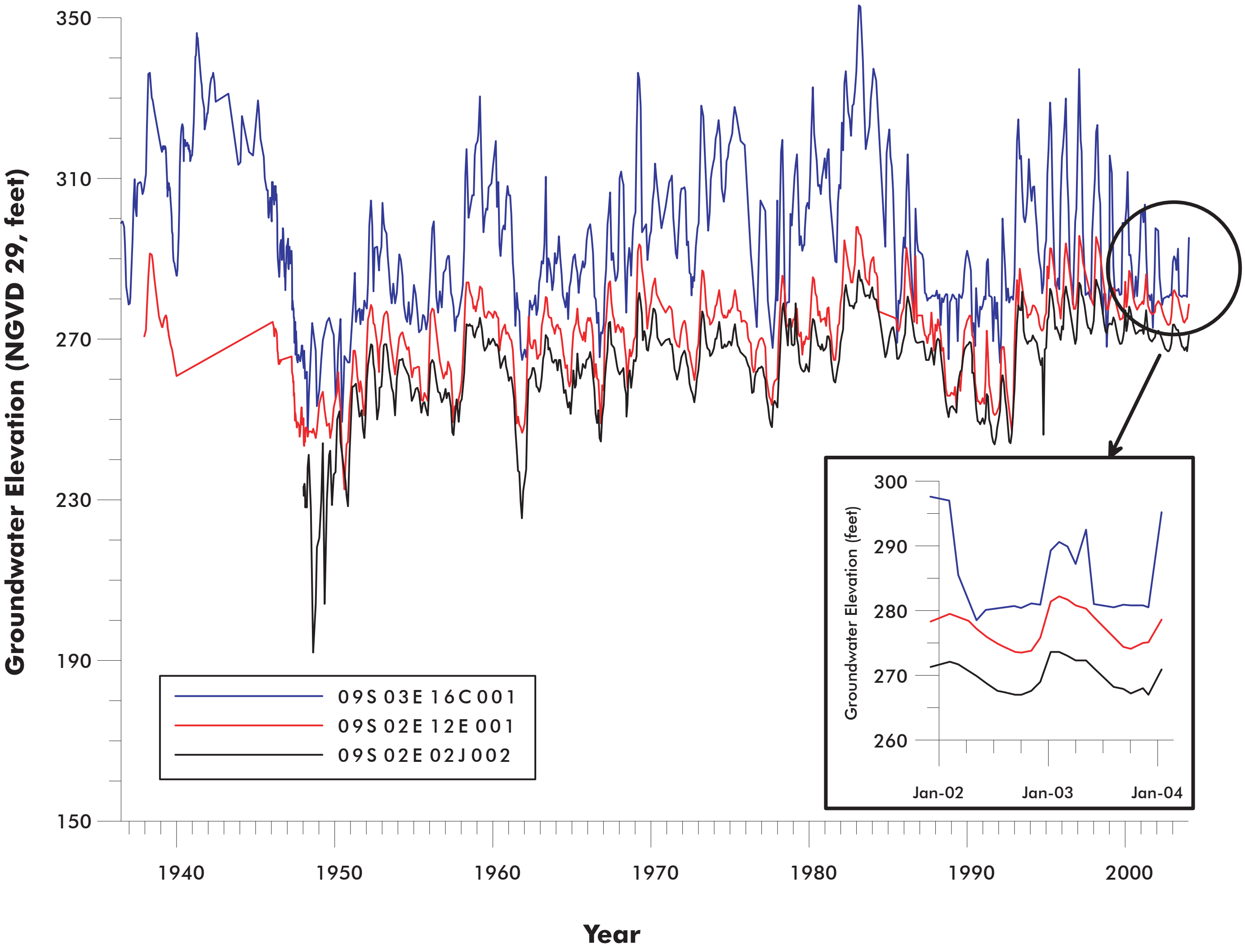
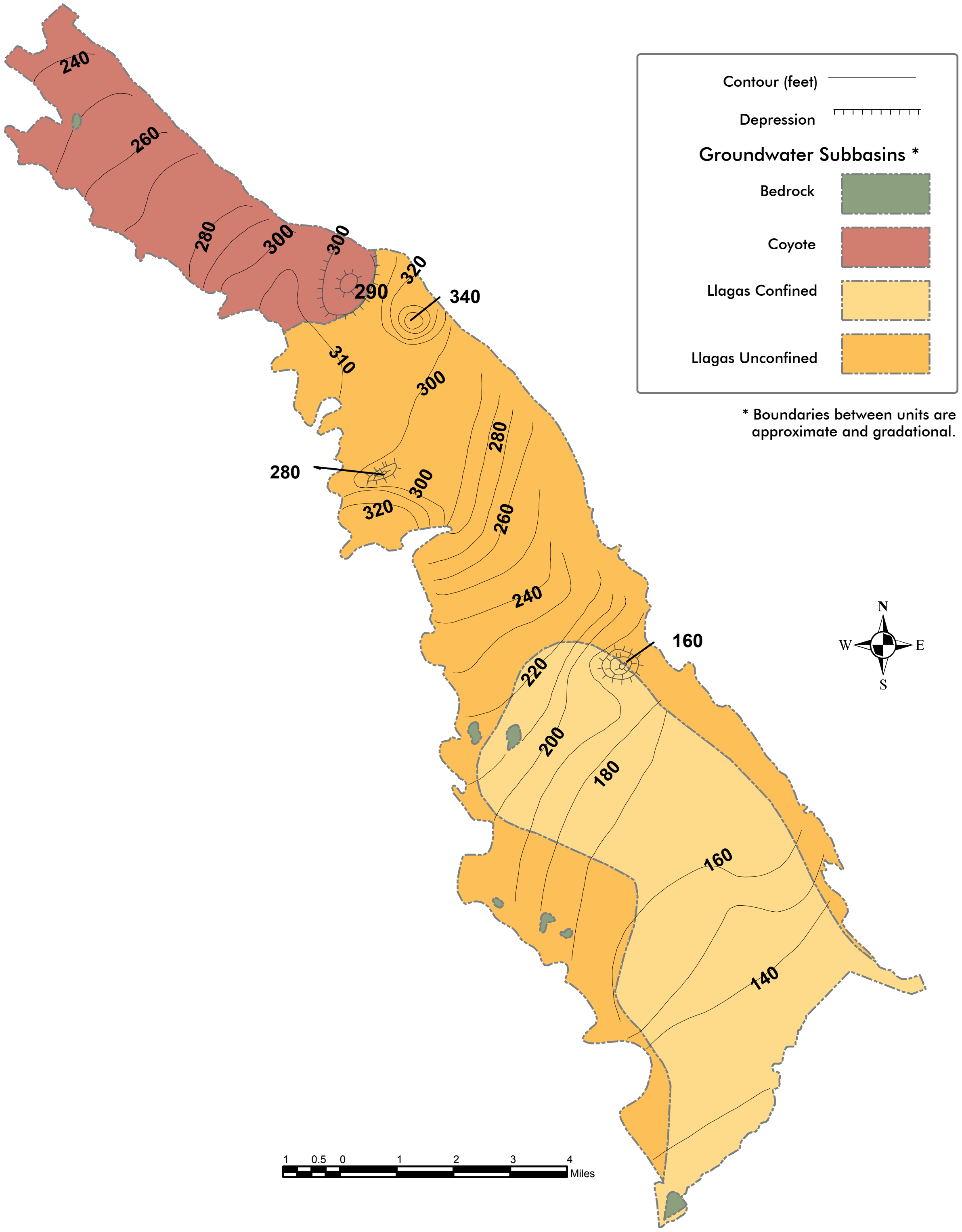


Figure 3-8

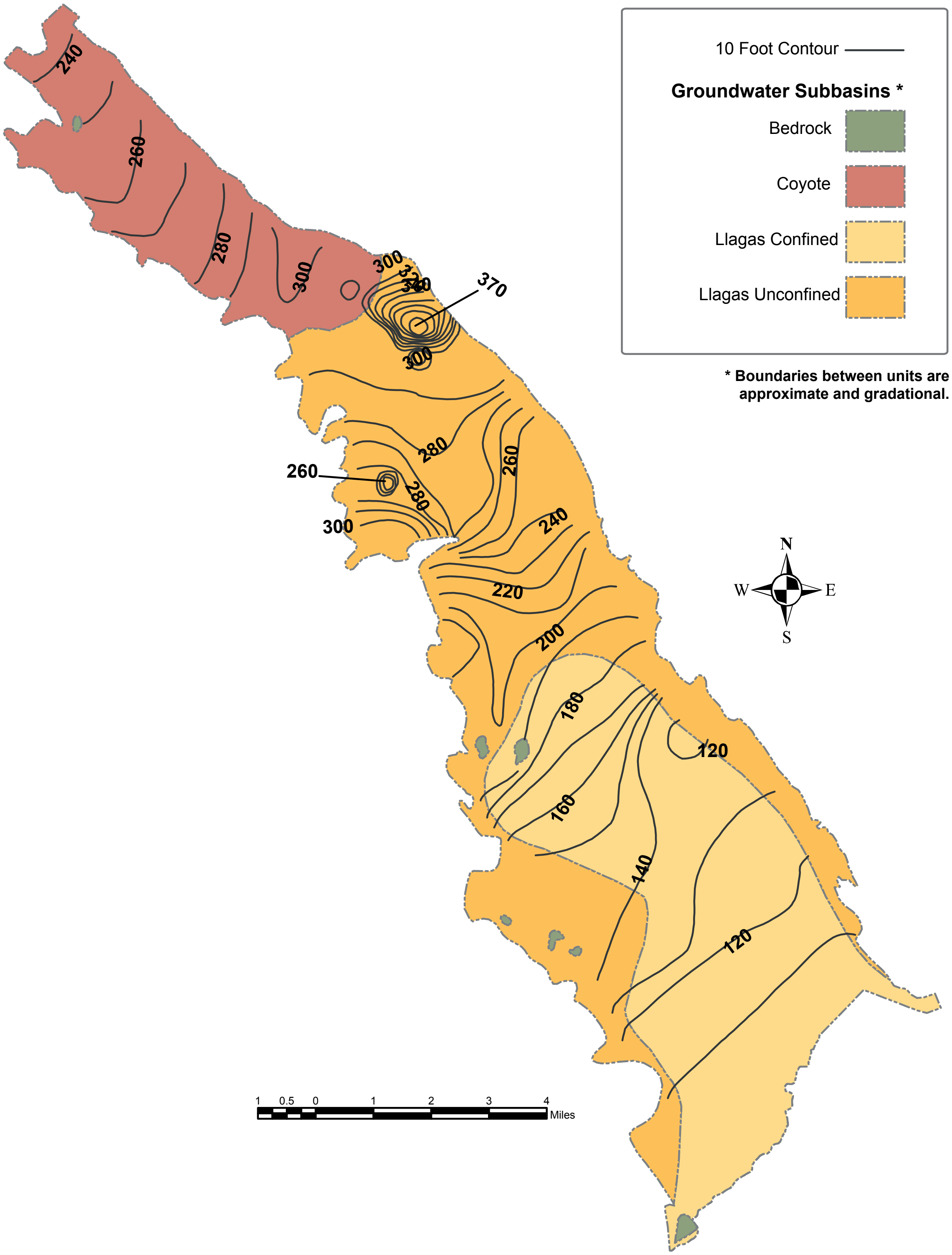
South County Groundwater Elevation Contour Map - Spring 2002



* Boundaries between units are approximate and gradational.

Figure 3-9

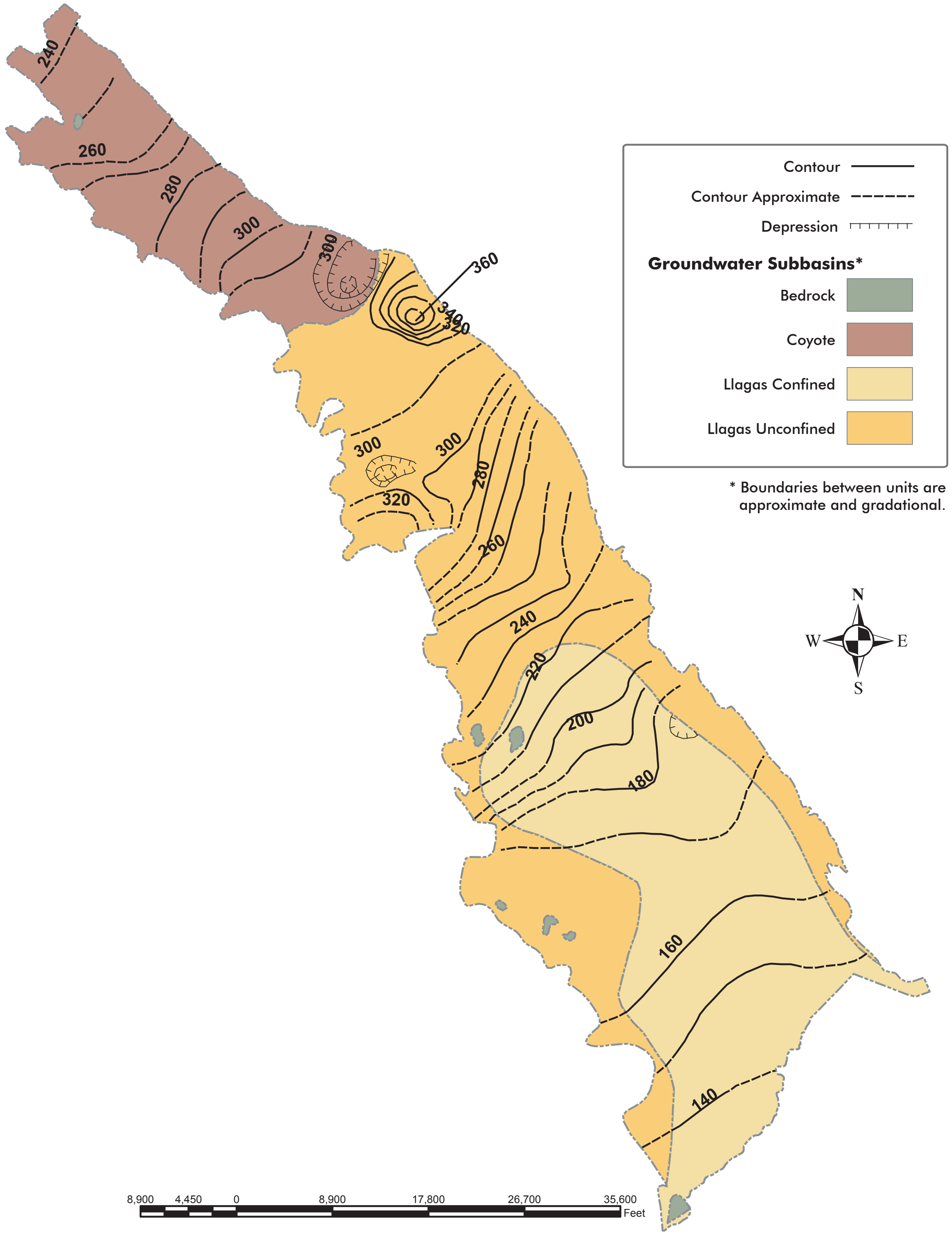
South County Groundwater Elevation Contour Map - Fall 2002



* Boundaries between units are approximate and gradational.

Figure 3-10

South County Groundwater Elevation Contour Map - Spring 2003



* Boundaries between units are approximate and gradational.

Groundwater Elevation Monitoring

Figure 3-11

South County Groundwater Elevation Contour Map - Fall 2003

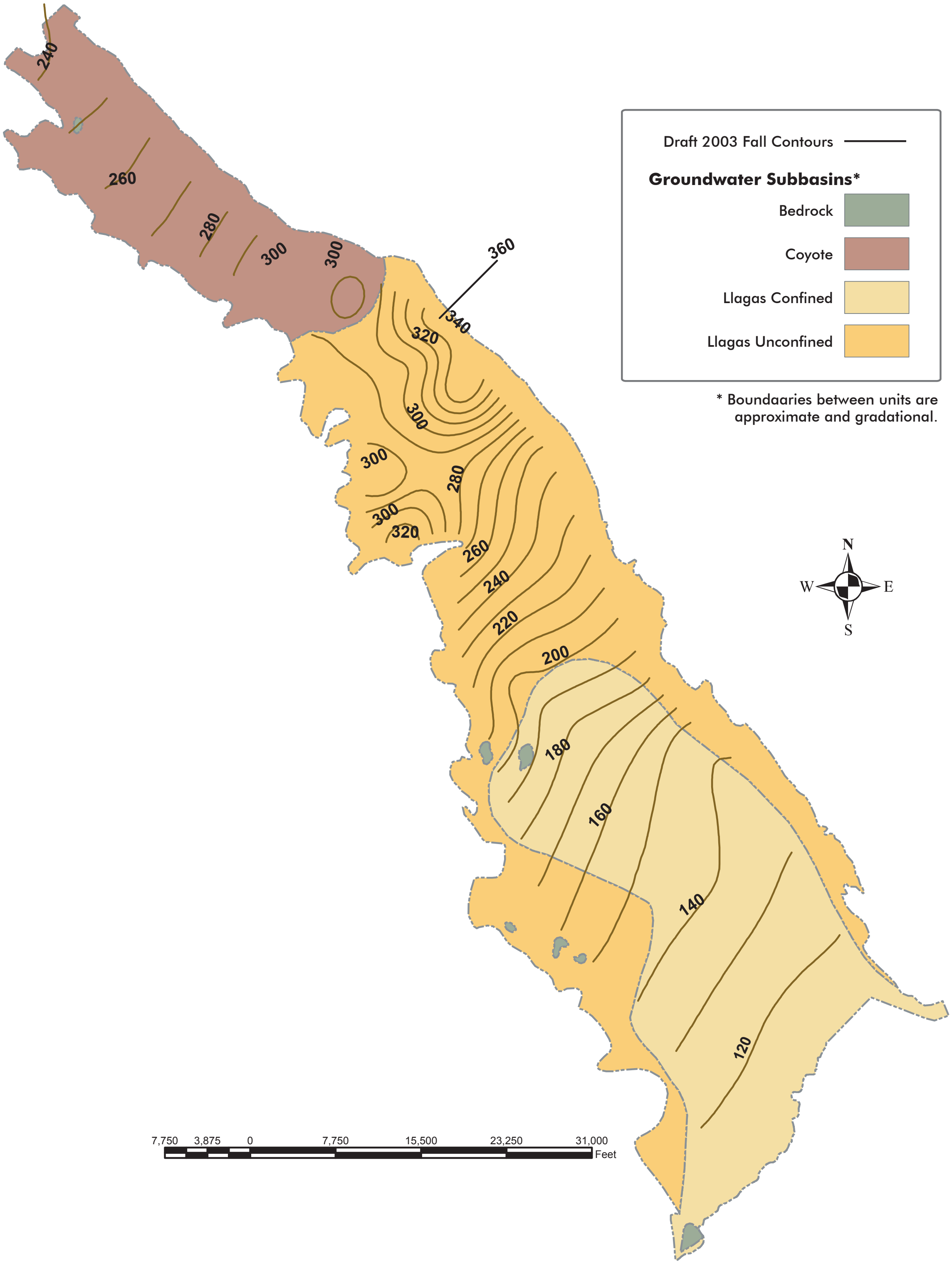


Figure 3-12

Hydrograph for the Llagas Subbasin Index Well (10S03E13D003)

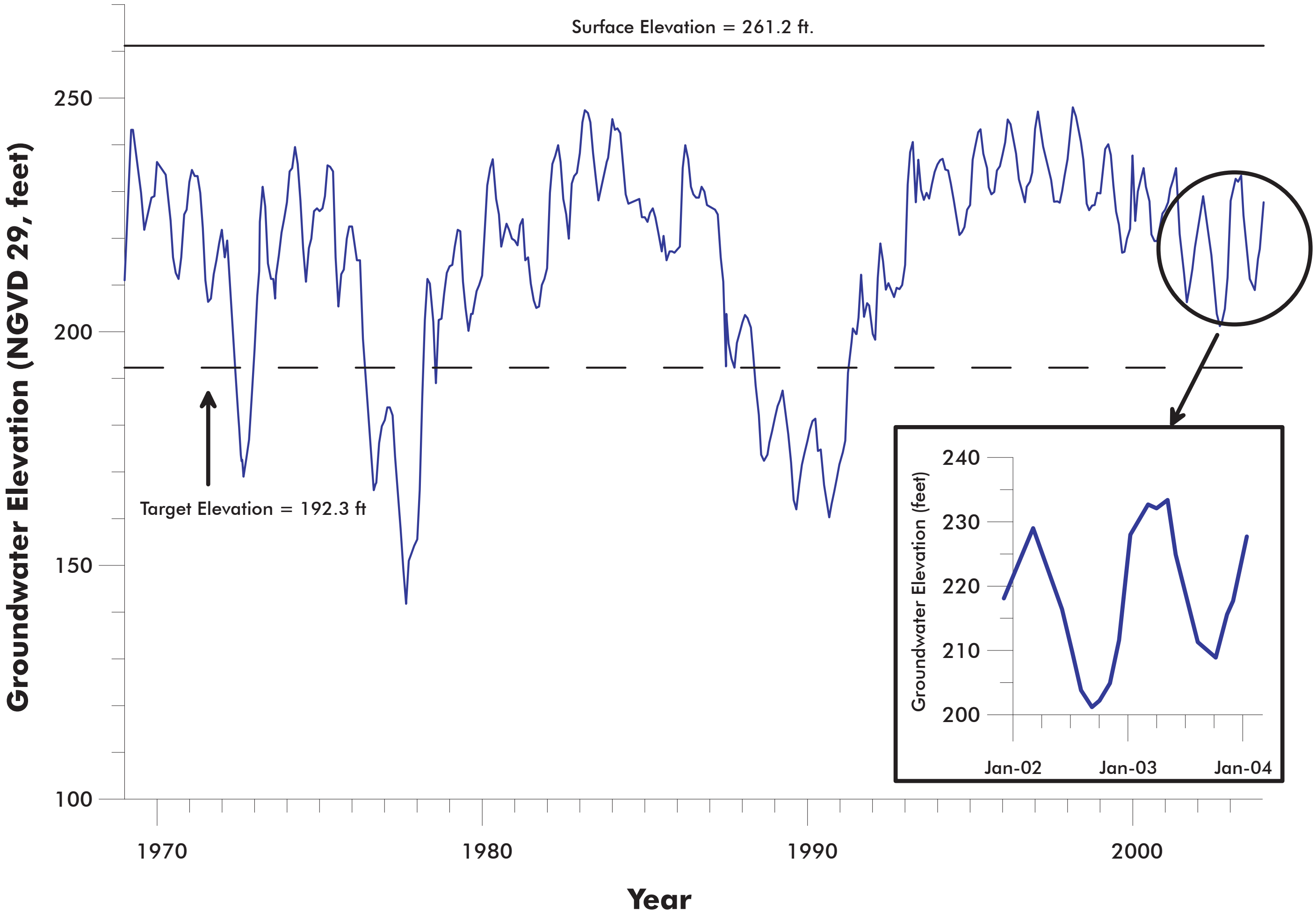


Figure 3-13

Annual Change in Storage for the Santa Clara Valley Subbasin 1993-2003

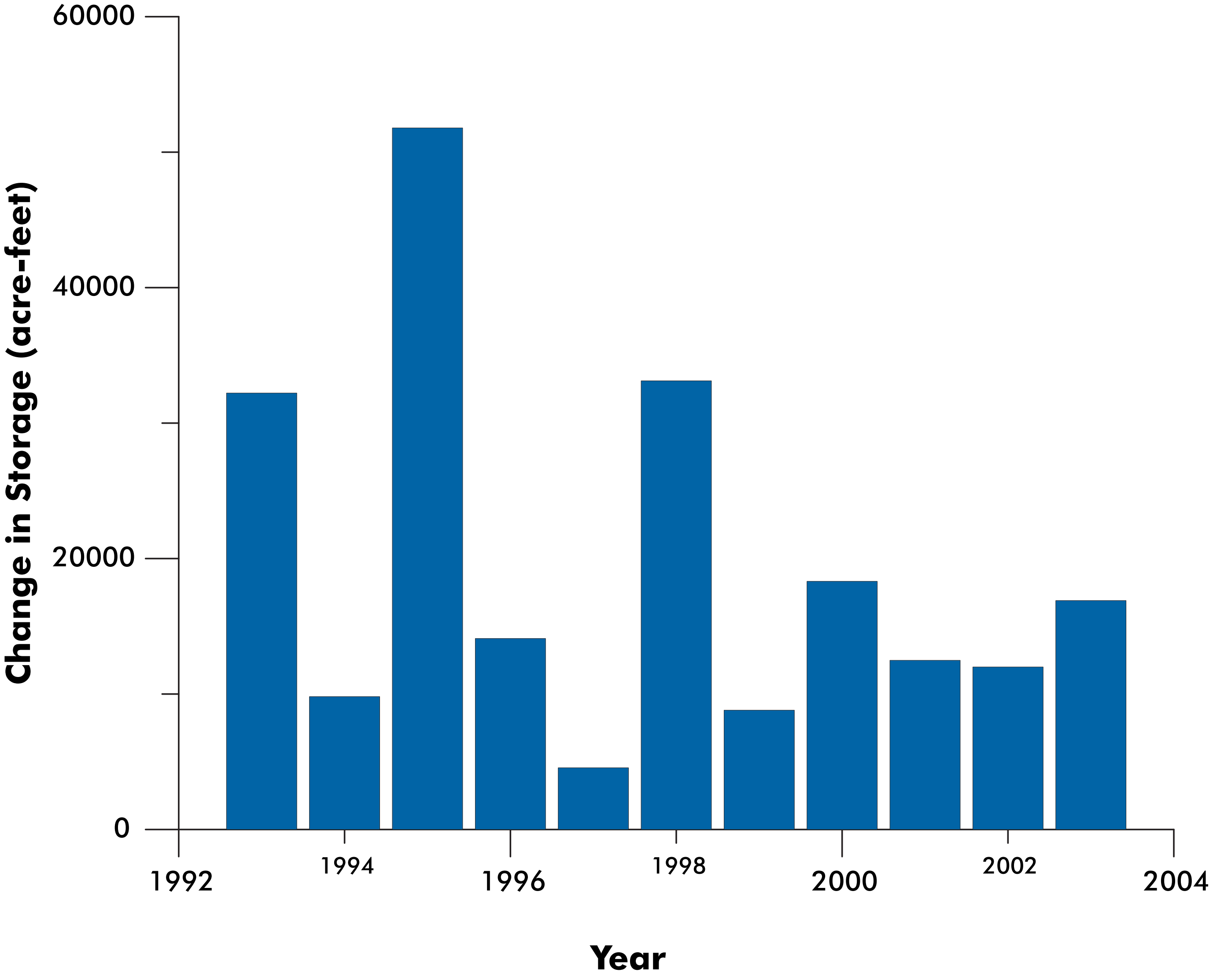
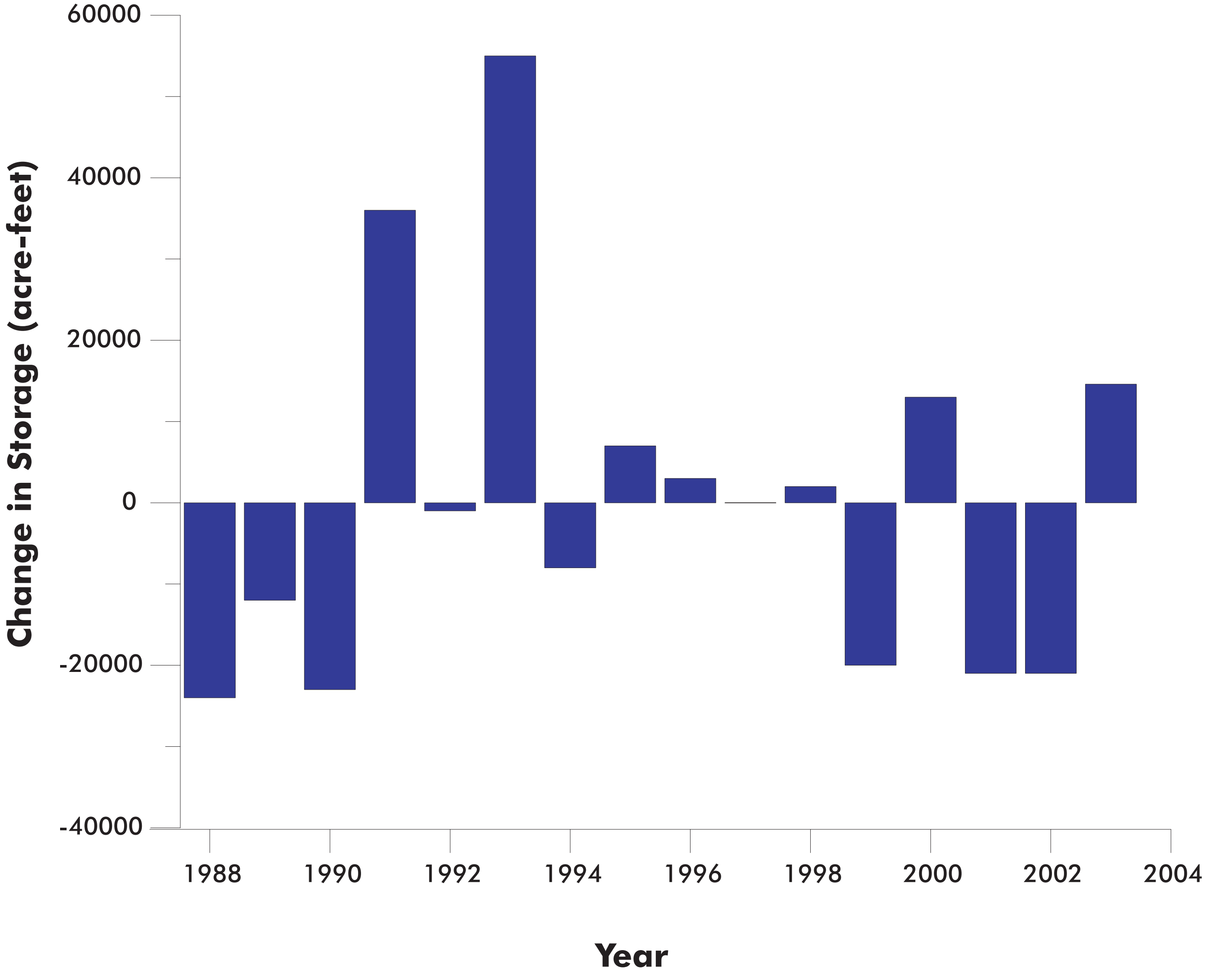


Figure 3-14

Annual Change in Storage for the Coyote and Llagas Subbasins 1988 - 2003



Land Subsidence Monitoring

4.0 Land Subsidence Monitoring

Excessive groundwater pumping from unconsolidated aquifer-aquitard systems, is often accompanied by land subsidence (Freeze and Cherry, 1979). Locally, this was first detected in 1919; by 1970, cumulative subsidence reached a maximum of 13 feet near downtown San Jose (Poland and Ireland, 1988), (Figure 4-1).

The consequences of subsidence are numerous and costly. Subsidence is associated with saltwater intrusion, exacerbated flooding, and damaged underground infrastructure. Dikes were constructed to prevent inundation of low lying areas fronting South San Francisco Bay. While excessive historical groundwater production (overdraft) resulted in subsidence, today it has been largely halted through the District's conjunctive management of water resources, including the groundwater replenishment program using locally conserved and imported surface water.

The District actively monitors for land subsidence by measuring water levels in numerous wells, by measuring compaction or expansion at two sites where changes in thickness of the aquifer-aquiclude systems is recorded using extensometers, and by traditional level surveys along three circuits (Figure 4-2). This monitoring shows that subsidence has been controlled to a rate of less than 0.01 ft/yr.

4.1 Extensometers

In 1960, the U.S. Geological Survey (USGS) installed extensometers with compaction recorders in two 1,000-foot deep boreholes drilled in the centers of historical subsidence areas in Sunnyvale and San Jose (Figure 4-2). Since the early 1980s, the District has monitored these extensometers to measure the rate and magnitude of expansion and compression that occurs between the land surface and the bottom of the well.

In the fall of 1998, the District installed electronic instrumentation at the San Jose extensometer site; depth-to-water and deformation readings are measured every 10 minutes, and are then averaged hourly and recorded on a data storage module. In the summer of 2001, electronic instrumentation for measuring deformation was installed at the Sunnyvale extensometer. Both the San Jose and Sunnyvale extensometer sites are visited quarterly to collect the hourly readings and analog charts, and to check instrument calibration.

Daily depth-to-water and deformation readings from the San Jose extensometer are shown on Figures 4-3 and 4-4. The period plotted represents two years of data beginning January 2001, and ending January 2003 (Figure 4-3), and two years from January 2002, ending January 2004 (Figure 4-4). The data reflect seasonal fluctuations in water levels and associated compaction and expansion of the aquifer system in San Jose. Note that deformation (as shown in black on the graph) does not necessarily correspond to an equivalent amount of permanent land subsidence. Extensometer data indicate that nearly all the deformation that occurred in 2002 and 2003 was in the elastic range.

4.2 Subsidence Index Wells

Subsidence thresholds, or groundwater elevations below which significant subsidence will likely occur, have been established. These thresholds were determined by using a subsidence model called PRESS (Predictions Relating Effective Stress and Subsidence). PRESS is a one-dimensional numerical model used to calculate subsidence as a result of changes in pressure head. The District established a tolerable rate of subsidence of 0.01 feet per year, which is based on the arithmetic average of historical subsidence and rebound as measured in the Sunnyvale and San Jose extensometers for the eleven-year period 1980-1990 (Geoscience, 1991). The PRESS model was used to determine water levels corresponding to this subsidence rate in the vicinity of ten subsidence index wells throughout the Santa Clara Valley Subbasin (Figure 4-2 and Table 4-1). Groundwater management and water supply planning activities are designed to minimize the risk of subsidence by maintaining groundwater elevations above these thresholds in the Santa Clara Valley Subbasin.

In 2002 and 2003, water level data were collected monthly or quarterly from eight of the ten original subsidence index wells. Two of the subsidence index wells have been destroyed by the well owners; the District is currently investigating suitable replacements in the vicinity of these destroyed wells. Minimum groundwater levels for eight of the subsidence index wells in the Santa Clara Valley Subbasin are summarized in Table 4-1. The minimum groundwater levels (corresponding to the maximum aquifer stress) generally occur in the fall. As shown in Table 4-1, all minimum groundwater elevations at the PRESS index wells for 2002 and 2003 were well above the established subsidence thresholds.

4.3 Level Circuit

Subsidence in northern Santa Clara County was first detected in 1919 after an initial level survey conducted in 1912 by the National Geodetic Survey. At that time, 0.4 feet of subsidence was measured in San Jose. Between 1912 and 1932, over 3 feet of subsidence was measured at the same location (which equated to a subsidence rate 0.15 ft/yr). As a result of this drastic increase in subsidence, an extensive leveling network was established for periodic measuring to evaluate the magnitude and geographical extent of subsidence.

For the purpose of subsidence monitoring, the District surveys a series of benchmarks (the Cross Valley level circuit, which includes the Guadalupe spur) annually each fall. Surveying of the Cross Valley circuit was conducted almost annually from 1960 through 1976, once in 1983, and annually from 1988 to the present. The Alum Rock level circuit has been surveyed semi-annually, in the spring and fall since 1999. These circuits are shown in Figure 4-2.

In 2002, the Cross Valley level circuit was surveyed in October and the Alum Rock level circuit was surveyed in May and October. Data from the survey were considered suspect as they were, in part, contradictory to other data and therefore no analysis or conclusions are made herein. New protocols that will be implemented on the next level run will significantly improve the data set in following years.

4.4 Other Efforts to Monitor Subsidence

In 2003, the District and researchers from U.C. Berkeley completed a cooperative study to determine if permanent land subsidence due to groundwater production has occurred in South County. Researchers analyzed high-resolution satellite images and groundwater production data to determine if there are significant changes in land surface elevation that can be attributed to groundwater pumping. The study found that there was no long-term subsidence or long-term uplift in South Santa Clara Valley. There is seasonal deformation, but it appeared to be elastic and recoverable.

Land Subsidence Monitoring

Table 4-1

Predictions Relating Effective Stress and Subsidence (PRESS) Model Index Well Summary for 2002 and 2003

PRESS Index Well	Well Number	Subsidence Threshold Elevation (ft)	Date Measured	2002 Minimum Groundwater Elevation (ft)	Feet Above Subsidence Threshold	Date Measured	2003 Minimum Groundwater Elevation (ft)	Feet Above Subsidence Threshold
1	08S01W03K013	166	7/9/02	216.3	50.3	6/18/03	216.7	50.7
2	08S01E05N002	-23	10/17/02	139	162	9/30/03	142	165
3		-146	NA[1]	NA[1]	NA	NA[1]	NA[1]	NA
Substitute for well 3[2]	07S01E02J021	-100	10/22/02	71	171	9/29/03	69.5	171
4	06S01W24H015	-18	6/12/02	>40	58	9/23/03	>40	58
5	07S01W22E002	-45	7/23/02	11.5	56.5	1/14/03	66.1	111.1
6	07S01W06P001	-47	10/01/02	65	112	3/31/03	29	74
7	06S02W21A001	-26	NA[1]	NA[1]	NA	NA[1]	NA[1]	NA
8	06S02W24CX7	-30	10/17/02	31.01	61.01	11/10/02	31.01	61.01
9	07S01W02G024	-35	NA[1]	NA[1]	NA	NA[1]	NA[1]	NA
10	07S01E16C006	-40	7/26/02	-14.8	25.2	3/24/03	54.9	94.9

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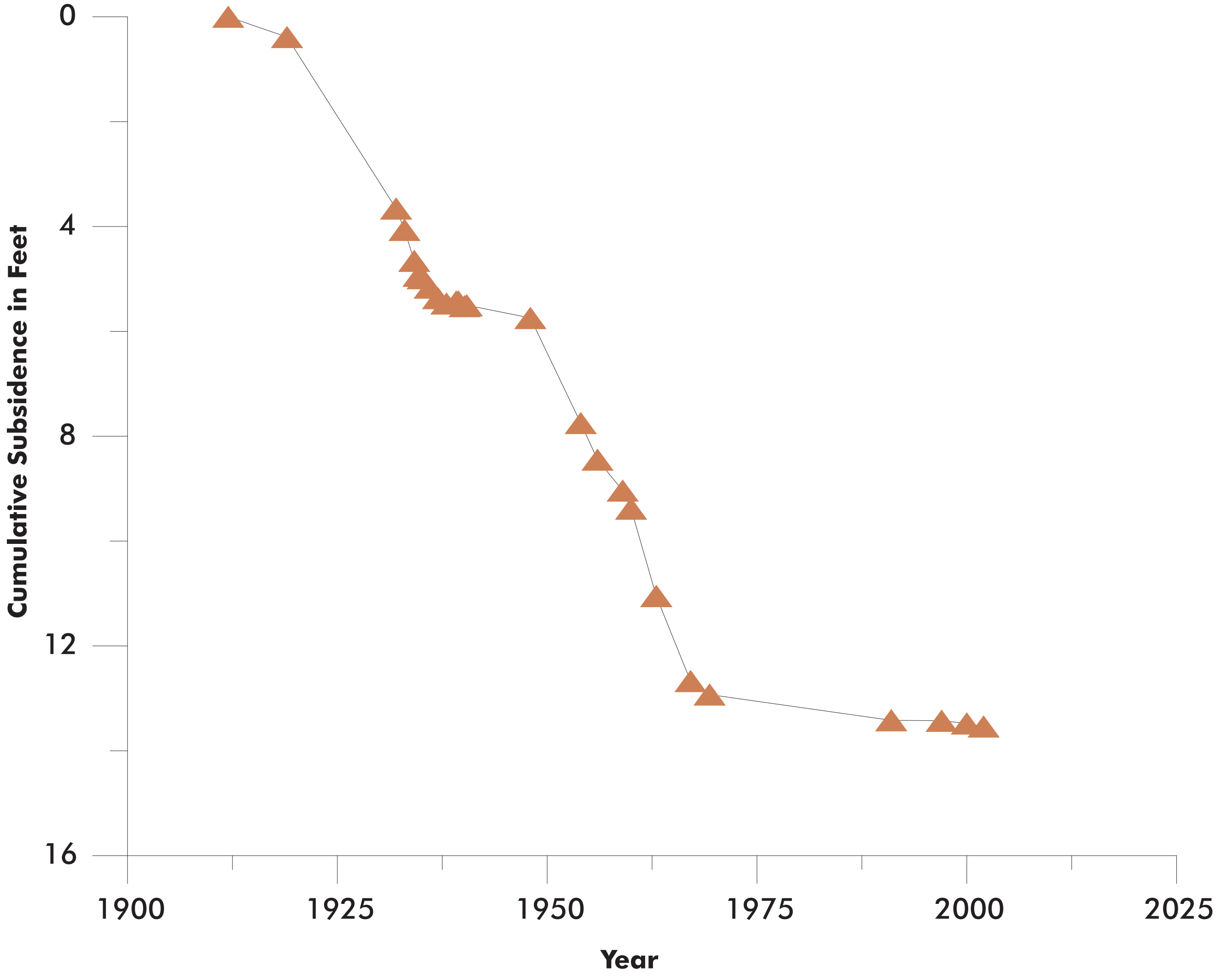
[1] No data available as the original subsidence index well was destroyed.

[2] As the established subsidence threshold is valid in the immediate vicinity of the original subsidence index well, data from a nearby well with a similar hydrograph is provided.

Figure 4-1

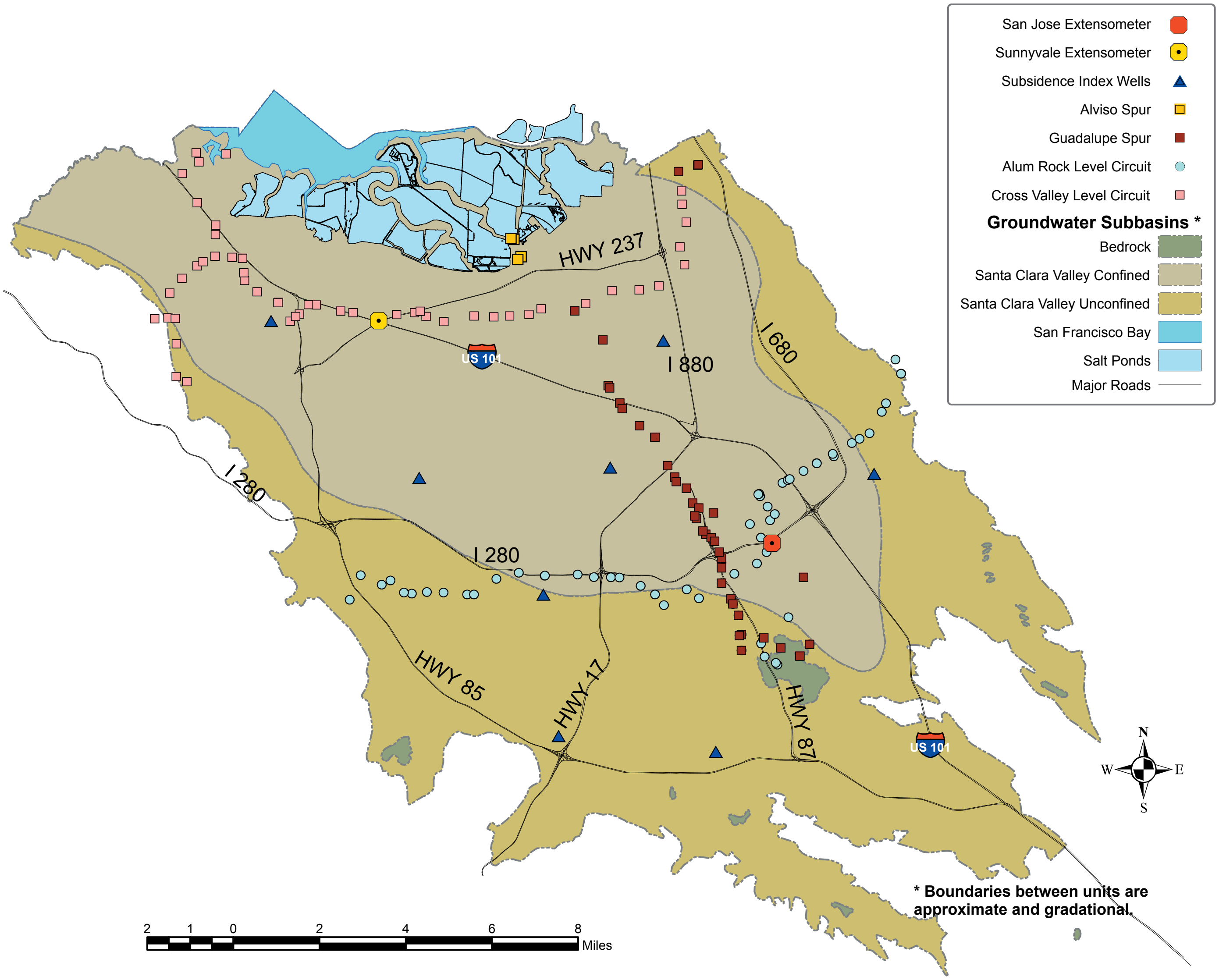
Benchmark P-7 Cumulative Subsidence



Land Subsidence Monitoring

Figure 4-2

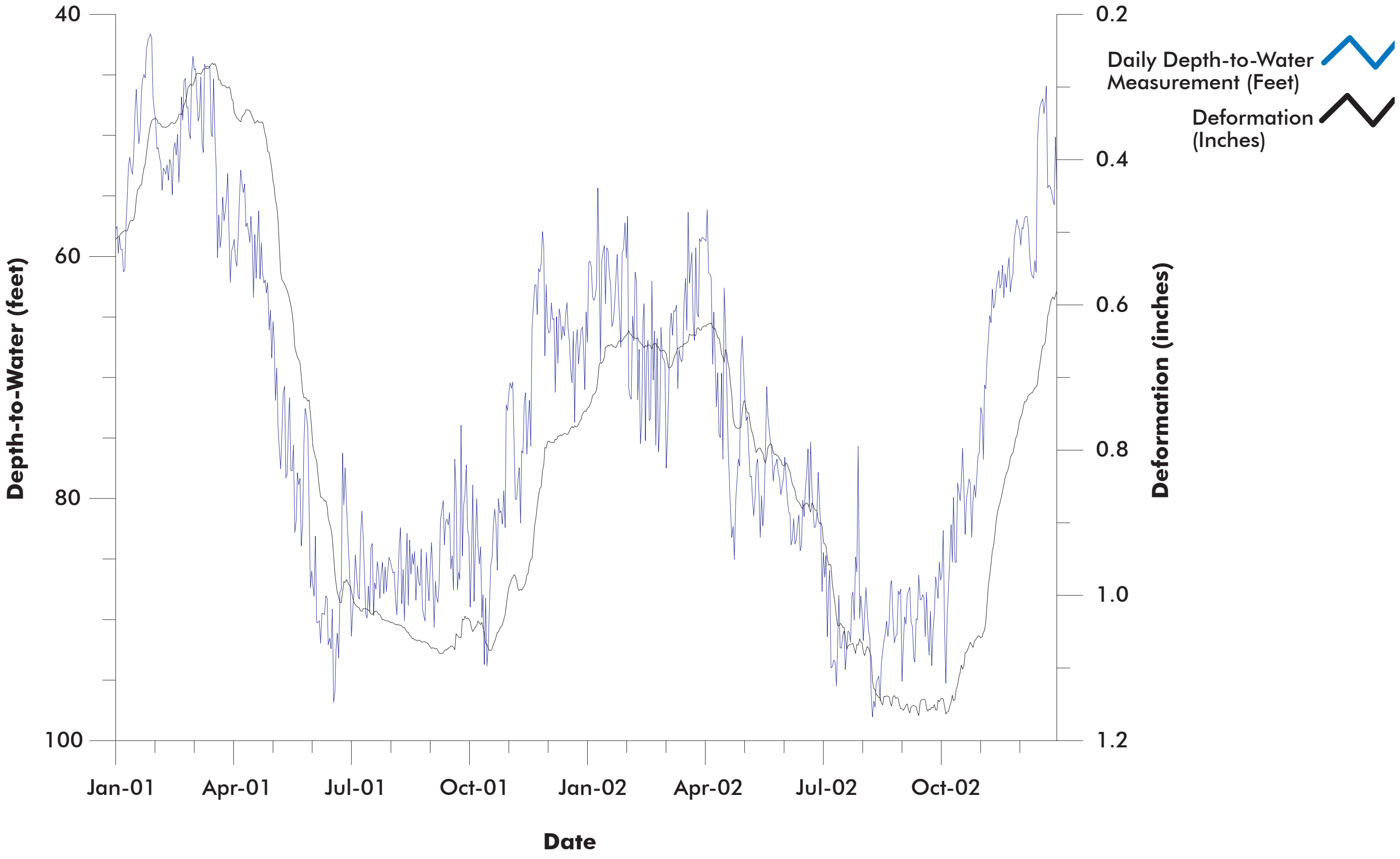
Subsidence Monitoring Locations



* Boundaries between units are approximate and gradational.

Figure 4-3

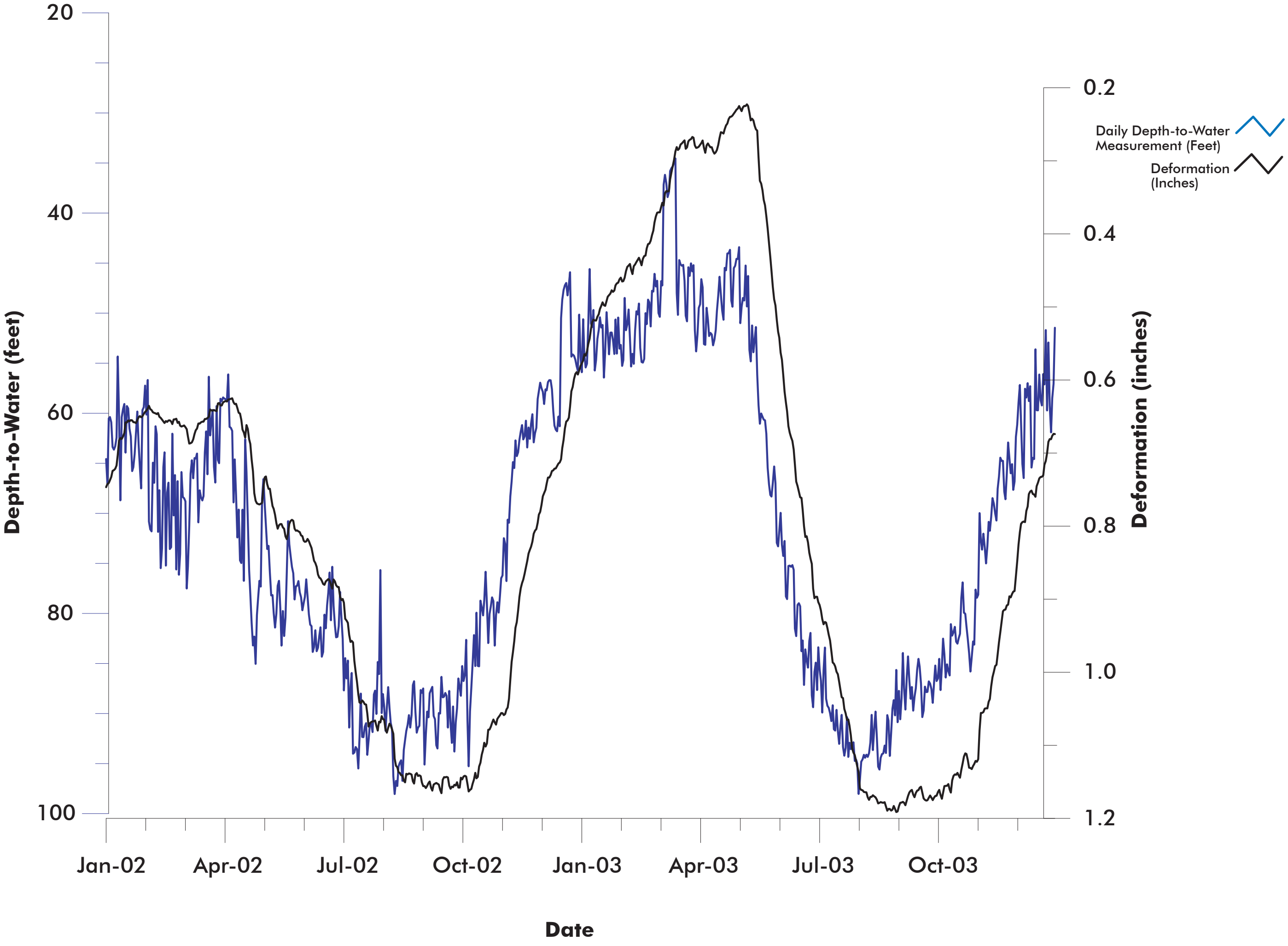
Stress/Deformation Data from San Jose Extensometer 2002



Land Subsidence Monitoring

Figure 4-4

Stress/Deformation Data from San Jose Extensometer 2003



5.0 Groundwater Quality

The dissolved matter present in groundwater depends on interactions between the atmosphere and rock minerals as rainwater falls to earth and eventually percolates into the subsurface. Certain natural geochemical processes in the aquifer, such as ion exchange, a natural water softening phenomenon, can further modify the dissolved constituent load. Compounds released into the environment by human activities (anthropogenic) contribute additional dissolved constituents to the groundwater, such as nutrients from fertilizer, fuels, solvents, and pesticides. The most common dissolved constituents in groundwater are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, and chloride. Other dissolved constituents may include nitrate, metals, or other chemicals usually present in much smaller concentration ranges. Certain physical properties are also measures of groundwater quality.

This section describes and discusses the results of general groundwater quality monitoring performed during 2002 and 2003. The District monitors groundwater quality throughout the groundwater subbasins to assess current conditions, evaluate trends, and identify areas of special concern. Groundwater monitoring provides data for assessing the suitability of groundwater for beneficial uses. The beneficial groundwater uses defined in the Regional Water Quality Control Board Water Quality Control Plans (Basin Plans) include agricultural, municipal and domestic, industrial process, and industrial supply. Lastly, monitoring results provide an indication of the effectiveness of various groundwater protection programs conducted by the District and others.

This section describes groundwater quality in principal aquifer zones and upper aquifer zones. Principal aquifer zones are aquifer zones from which most water is pumped for beneficial uses. Principal aquifer zones are deeper than upper aquifer zones and are typically under confined or semi-confined conditions. The principal aquifers of the subbasins produce water of very good quality for all designated beneficial uses, including drinking water supply. The upper aquifer zones occur above regional confining layers. Groundwater quality in upper aquifer zones is subject to more contamination from land use activities than the principal aquifer zones, the groundwater quality in the upper aquifer zones also meets water quality objectives for all beneficial uses.

The District and/or public water suppliers sampled a total of 396 wells in 2002. The locations of the sampled wells are illustrated in Figure 5-1. Of these 396 wells that were sampled, 145 wells were sampled for inorganic constituents other than nitrate, 348 wells were sampled for nitrate, 182 wells were sampled for volatile organic chemicals, 76 wells were sampled for pesticides, and 80 were sampled for radiological constituents.

The District and/or public water suppliers sampled a total of 473 wells in 2003. The locations of the sampled wells are illustrated in Figure 5-2. Of these 473 wells that were sampled, 139 wells were sampled for inorganic constituents other than nitrate, 307 wells were sampled for nitrate, 141 wells were sampled for volatile organic chemicals, 63 wells were sampled for pesticides and 51 wells were sampled for radiological constituents. The sampling results are discussed below.

5.1 Inorganic Water Quality

The vast majority of all constituents dissolved in groundwater are inorganic constituents. Under natural conditions, they are dissolved into solution as essentially pure rainwater percolates into the subsurface and dissolves minerals from rocks and soil. Some of these common constituents are abundant in earth materials and are soluble in water. Therefore, they typically occur in relatively large concentrations. Others are less abundant or are not very soluble in water and these commonly occur only in minute concentrations. The constituents which occur in relatively large concentrations are sometimes referred to as “major constituents” and those which occur in minute concentrations are termed “minor constituents” or “trace constituents”. A few other parameters are commonly included in standard water quality analyses (Hem, 1985), but do not fit well into either the major or minor constituent groups. For this report, they are grouped into a category called “miscellaneous”. The three primary constituent subgroups are itemized below and in Table 5 1:

- Major Constituents: calcium, magnesium, sodium, potassium, bicarbonate, chloride, sulfate, and silica
- Minor Constituents: arsenic, aluminum, barium, bromide, cadmium, chromium, copper, iron, lead, mercury, manganese, nickel, selenium, silver and zinc
- Miscellaneous: total dissolved solids, turbidity, alkalinity, hardness, boron, nitrate and fluoride

Monitoring of inorganic water quality constituents is important because changes in concentration over time could signal degradation in groundwater quality. The composition of the water-bearing material does not change, and changes in concentration over time could signal some kind of anthropogenic condition. For example, leachate from solid waste landfills contain elevated levels of some major groundwater constituents such as calcium, sodium, magnesium and chloride among others (Freeze and Cherry, 1979). If leachate from a particular landfill was escaping the site and impacting the groundwater system these constituents would become elevated over time. This would signal a manmade contamination requiring further anaysis.

The following sections describe mineral characteristics of the water in the groundwater subbasins and the occurrence of specific inorganic constituents of concern. Nitrate in groundwater is discussed separately in Section 5.2 below. Table 5-2 provides typical concentration ranges of common inorganic constituents. Typical concentration ranges are based on a statistical evaluation of the approximate 95 percent confidence interval estimate of the true population median. In other words, the given intervals have an approximate 95 percent probability of containing the true median concentration. This is a more reliable estimate of the true background concentration than using average, mean, or median concentration values from the sampling results (Helsel and Hirsch, 1992).

5.1.1 Mineral Characteristics

The mineral quality of water is classified based on the predominant cations and anions, the positively and negatively charged ions in the water sample. Major cations include calcium, magnesium, sodium and potassium. Major anions include bicarbonate, chloride, and sulfate. In some wells, nitrate can constitute a significant portion of the total anions. Water classifies as calcium bicarbonate when calcium constitutes more than 50 percent of the cations, in milliequivalents per liter, and bicarbonate constitutes more than 50 percent of the anions. Water in which no one cation or anion represents more than 50 percent of the total are mixed types and all important cations and anions are identified. Milliequivalents (meq) account for the charge of the different ions and provide a means for comparing the chemical equivalence of the different ions. The mineral classifications and ratios of different ions provide a means of grouping similar types of water together and highlighting similarities and differences among different water samples.

The mineral character of the groundwater subbasins is dominated by calcium, magnesium, and bicarbonate. Complete mineral analyses were performed for 139 wells in 2002. Of these, 33 had calcium magnesium bicarbonate, 32 had calcium bicarbonate and 12 had magnesium calcium bicarbonate. The remaining wells contained the following water types: calcium sodium bicarbonate (7), sodium calcium bicarbonate (4), sodium bicarbonate (3), calcium magnesium bicarbonate chloride (2), calcium magnesium bicarbonate sulfate (2), magnesium bicarbonate (2), and one each of calcium bicarbonate sulfate, magnesium calcium bicarbonate chloride, magnesium calcium bicarbonate sulfate, and mixed cation mixed anion. The ratio of cations to anions in the remainder of the samples (38) did not balance within the acceptable range of ± 10 percent. Figures 5-3 and 5-4 show the 2002 mineral character of groundwater in the principal aquifer zones of North County and South County, respectively.

For 2003, complete mineral analyses were performed for 113 wells. Of these, 62 had calcium magnesium bicarbonate, 32 had magnesium calcium bicarbonate, 5 had missed cation bicarbonate, 5 had sodium chloride, 3 were sodium bicarbonate, and one each of calcium mixed anion, calcium magnesium mixed anion, mixed calcium chloride, mixed cation mixed anion and sodium mixed anion. The ratio of cations to anions did not balance within the acceptable range of + 10 percent for 13 of the 113 wells. Figures 5-5 and 5-6 show the 2003 mineral character of groundwater in the principal aquifer zones of North County and South County, respectively.

5.1.2 Total Dissolved Solids

Total dissolved solids (TDS), a measurement of the solids dissolved in water, is a primary measurement of water quality. TDS is not a specific chemical but a sum of non-evaporative constituents dissolved in water. As water is pumped out of the ground and is put to beneficial use, a large percentage of the water is taken up by plants, evaporates, or is otherwise utilized, but most of the dissolved solids in the water are not. These dissolved solids, such as salts, are concentrated in the water that returns to groundwater through infiltration. Over time, this process can result in increased TDS concentrations if sufficient natural recharge is not occurring. In addition, specific land or water uses can contribute TDS to groundwater.

Very high concentrations of TDS can cause drinking water to taste salty and make it unusable for some beneficial uses. In addition, high TDS concentrations may indicate that the concentration of one or more dissolved constituents is high and that more detailed water quality analysis is warranted. DHS has established a secondary MCL, or drinking water standard, range for TDS. The range is from 500 milligrams per liter (mg/L) to 1,000 mg/L, though the 500 mg/L concentration is recommended. Concentrations of TDS up to 1,500 mg/L may be permissible on a short-term basis only. It is important to recognize that TDS concentrations in groundwater need to be maintained below the MCL in order to meet beneficial uses and that short-term TDS limits should not be applied to long-term groundwater quality conditions.

Typical TDS concentrations in the primary water supply aquifers of Santa Clara County are below the recommended MCL of 500 mg/L. Concentrations in the upper aquifer zones are higher, with typical concentrations ranging from 340 to 740 mg/L, but still within the drinking water standard range. TDS concentrations did not exceed the drinking water standard in 2002. In 2003, TDS concentrations exceeded the drinking water standard in two wells in the principal aquifer zone in the Santa Clara Valley Subbasin. The drinking water standard for specific conductance, which correlates to TDS concentrations, was exceeded in the one well in the upper zone of the Santa Clara Valley Subbasin in 2002 and was exceeded in four wells in 2003, three in the Santa Clara Valley Subbasin and one in the Llagas Subbasin.

5.1.3 Hardness

Hardness is based on the calcium and magnesium content of water. It is typically reported as the equivalent concentration of calcium carbonate ($CaCO3$). There is no drinking water standard for hardness, but calcium and magnesium are both necessary nutrients. The most common problems associated with hardness are scaly residues on fixtures and difficulty lathering. Water with hardness (as CaCO3) concentrations less than or equal to 60 mg/L are commonly classified as soft or slightly hard. Waters with hardness (as CaCO3) concentrations between 60 and 180 are moderately hard or hard. Water with a hardness (as CaCO3) concentration above 180 is classified as very hard.

Waters in the Santa Clara County groundwater subbasins are very hard, with typical concentrations ranging from 180 to 340 mg/L hardness (as CaCO3). Only 21 wells of 145 wells had hardness values equal to or below 180 mg/L hardness (as CaCO3) in 2002, and only 11 wells of 137 had hardness values equal to or below 180 mg/L hardness (as CaCO3) in 2003.

5.1.4 Manganese

Manganese is a naturally occurring constituent in drinking water. The drinking water standard for manganese is 50 micrograms per liter (ug/L), which is a secondary standard. Manganese concentrations above 50 ug/L may cause a black to brown color, black staining, or a bitter metallic taste. Higher concentrations can alter water's taste or smell. Manganese is not a health concern at the concentrations typically found in groundwater.

Manganese concentrations were generally below the drinking water standard of 50 ug/L, but there were isolated exceedences in 21 wells for 2002. Concentrations of manganese above 50 ug/L were detected in 11 wells in the principal aquifer zone of the Santa Clara Valley Subbasin, nine wells in the upper aquifer zone of the Santa Clara Valley Subbasin, and one well in the upper zone of the Llagas Subbasin. All of the exceedences in the Santa Clara Valley Subbasin were in the northern third of the confined area near San Francisco Bay. The maximum manganese concentration detected was 504 ug/L in the upper zone of the Santa Clara Valley Subbasin, near San Francisco Bay.

Manganese concentrations for 2003 which exceeded 50 ug/L were detected in 19 wells in the principal aquifer zone of the Santa Clara Valley Subbasin, six wells in the upper aquifer zone of the Santa Clara Valley Subbasin, three wells in the principal aquifer zone of the Llagas Subbasin and one well in the upper aquifer zone of the Llagas Subbasin. The maximum manganese concentration detected was 1340 ug/L in the upper zone of the Santa Clara Valley Subbasin.

5.1.5 Iron

Iron is another naturally occurring constituent in drinking water. The drinking water standard for iron is 300 ug/L, which is a secondary standard. Iron concentrations exceeding 300 ug/L can cause rusty color, sediment, a metallic taste, and reddish or orange staining. Iron is a necessary nutrient and typically concentrations in groundwater are not a health concern.

Iron concentrations were generally below the drinking water standard of 300 ug/L, but there were isolated exceedences in 14 wells in 2002. Iron concentrations above 300 ug/L were detected in nine wells in the principal aquifer zone of the Santa Clara Valley Subbasin, two wells in the upper aquifer zone of the Santa Clara Valley Subbasin, one well in the upper aquifer zone of the Llagas Subbasin, one well in the principal aquifer zone of the Llagas Subbasin and one well in the Coyote Subbasin. The maximum iron concentration detected was 11,000 ug/L in the principal aquifer zone of the Santa Clara Valley Subbasin in 2002.

In 2003, iron concentrations were generally below the drinking water standard, but there were isolated exceedences in 17 wells. Iron concentrations above 300 ug/L were detected in 11 wells in the principal aquifer zone of the Santa Clara Valley Subbasin, one well in the upper aquifer zone of the Santa Clara Valley Subbasin, and five wells in the principal aquifer zone of the Llagas Subbasin. The maximum iron concentration detected was 2,800 ug/L in the upper aquifer zone of the Santa Clara Valley Subbasin.

5.1.6 Chloride

Many coastal groundwater subbasins experience some form of seawater encroachment into fresh water aquifers. Under natural conditions in Santa Clara County, seaward hydraulic gradients hold the high chloride waters at bay, limiting the impact. As water demands and pumping increase, hydraulic gradients can change from seaward to landward and high chloride waters can be drawn into fresh water aquifers. Detecting this condition is very important as a severe case of seawater intrusion can render fresh water aquifers useless for almost all beneficial uses.

A zone of saltwater intrusion has been observed along San Francisco Bay, in the northern portion of the Santa Clara Valley Subbasin less than 100 feet below ground surface. The 100 mg/L chloride isoconcentration contour defines the extent of intrusion, illustrated in Figures 5-7 and 5-8. This area encompasses approximately 18 square miles of the upper aquifer zone along San Francisco Bay and the salt evaporation ponds, from Highway 101 on the west to Highway 880 on the east. Intrusion extends as much as three miles landward from the salt evaporation ponds along the Guadalupe River.

The District has monitored saltwater intrusion since the early 1980s. At present, the area affected by saltwater intrusion appears to be stable. Statistical analysis of quarterly monitoring data from the period from 1998 to 2001 showed evidence of a downward trend in several wells, while no evidence of a trend was observed in the remaining wells. In addition, little difference can be observed in the location of the 100 mg/L chloride isoconcentration contour from 1985 reports to the current contour. The stability of saltwater intrusion is attributed to the District's groundwater management programs, which have been successful at minimizing land subsidence that is associated with saltwater intrusion, and to District programs to destroy abandoned wells that may transmit high chloride waters from one aquifer zone to another.

The drinking water standard for chloride is 600 mg/L, which is a secondary standard, and the agricultural water quality objective is 355 mg/L. High chloride concentrations in drinking water can impart a salty taste. High chloride concentrations in irrigation water can damage some plants. Chloride concentrations above 355 mg/L were detected in two wells in 2002, both of which are in the Santa Clara Valley Subbasin. Chloride concentrations above 355 were detected in nine wells in 2003, but only three of those nine were above the secondary drinking water standard of 600 mg/L. The three wells which exceed drinking water standards are all in the Santa Clara Valley Subbasin. None of these wells are water production wells; most of the wells are monitoring wells in the upper zone in the area of known saltwater intrusion, one well is a monitoring well for the principal aquifer in the area of known saltwater intrusion, two wells exceed the agricultural water quality objective in the principal aquifer zone of the Llagas Subbasin.

5.1.7 Boron

Boron is a naturally occurring inorganic constituent found in groundwater, usually at low concentrations. While boron in drinking water does not pose a known human health hazard, it is toxic to some plants at higher concentrations. The agricultural water quality objective for boron is 200 ug/L. Boron concentrations in most wells were below the agricultural objective, but there were 16 exceedences in 2002. Boron concentrations above 200 ug/L were detected in seven wells in the principal aquifer zone of the Santa Clara Valley Subbasin, seven wells in the upper zone of the Santa Clara Valley Subbasin, and two wells in the upper aquifer zone of the Llagas Subbasin. In 2003, boron concentrations above 200 ug/L were detected in thirteen wells in the principal aquifer zone of the Santa Clara Valley Subbasin, eight wells in the upper zone of the Santa Clara Valley Subbasin, four wells in the principal aquifer zone of the Llagas Subbasin, and two wells in the upper aquifer zone of the Llagas Subbasin. None of the wells in which boron was detected above 200 ug/L are used for agricultural water supply.

5.1.8 Turbidity

Turbidity is a measurement of the clarity of drinking water. The drinking water standard for turbidity is 5 Nephelometric Turbidity Units (NTU). For groundwater, this is a secondary standard related to the appearance of the water. In 2002, the turbidity standard was exceeded in eleven wells, with a maximum turbidity of 72 NTU. Nine of these wells are monitoring wells. The remaining wells are public water supply wells, with turbidity values of 72 NTU and 46 NTU. In 2003, the turbidity standard was exceeded in eight wells, with a maximum turbidity of 87 NTU. Six of the wells are monitoring wells, two are public water supply wells and one was an agricultural supply well.

5.1.9 Aluminum

Aluminum is naturally occurring groundwater constituent. Aluminum has both a primary and secondary drinking water standard. The primary drinking water standard for aluminum, which is 1,000 ug/L, protects against adverse gastrointestinal tract affects. The secondary standard is 200 ug/L and protects consumers from concerns regarding taste, odor or appearance of water. In 2002, aluminum was detected above the primary drinking water standard in one well in the principal aquifer of the Santa Clara Valley Subbasin. A second well water sample from the same area contained aluminum above the secondary drinking water standard. Both of these wells are drinking water supply wells.

In 2003, aluminum was detected above the primary drinking water standard in one monitoring well in the principal aquifer of the Llagas Subbasin. Aluminum was detected above the secondary drinking water standard in three wells in the principal aquifer zone of the Santa Clara Valley Subbasin, one well in the upper aquifer zone of the Santa Clara Valley Subbasin, one well in the principal aquifer zone of the Llagas Subbasin, and one well in the upper aquifer zone of the Llagas Subbasin. Three of these wells are drinking water supply wells.

5.1.10 Selenium

Selenium is a naturally occurring, essential nutrient which occurs in groundwater. High concentrations of selenium can cause adverse neurological affects. The drinking water standard for selenium is 50 ug/L and the agricultural water quality objective is 20 ug/L. Higher concentrations of selenium in irrigation water can cause adverse wildlife affects due to selenium build-up in the environment. Selenium above the agricultural water quality objective was detected in one well in the upper zone of the Santa Clara Valley Subbasin in 2002. This well is used for agriculture. Selenium was not detected above the agricultural water quality objective in 2003.

5.1.11 Other Inorganic Constituents

Other inorganic constituents, including arsenic and chromium, were not detected above their drinking water standards, nor were they detected in concentrations in excess of what would be considered naturally occurring with one exception. Perchlorate, which does not yet have a drinking water standard, was detected in the Llagas Subbasin. The detections are discussed in Section 5.3.1.

5.2 Nitrate

Nitrate in the environment comes from both natural and anthropogenic sources. Naturally-occurring nitrate is formed in soil by bacteria and in the atmosphere by lightning. Anthropogenic nitrate is formed by fossil fuel combustion and the use of fertilizers. Nitrate is very soluble in water, so it is readily dissolved in rainfall or irrigation water that infiltrates to groundwater. In addition, nitrate is stable in most groundwater systems. Other forms of nitrogen that can occur in the groundwater are nitrite, ammonium, ammonia, and nitrogen gas. Small amounts of nitrate in groundwater (less than 10 mg/L) are normal, but higher concentrations suggest an anthropogenic origin. Common anthropogenic sources of nitrate in groundwater are fertilizers, septic systems, and animal waste. Wastewater discharges from food processing plants and recycled water can also contain high nitrate concentrations. The drinking water standard for nitrate is 45 mg/L as nitrate. This standard is based on protecting infants, who are susceptible to health effects from nitrate in drinking water. Since the Santa Clara Valley has a long history of agricultural production and septic systems are still in use in the unincorporated areas of the County, monitoring for nitrate contamination is an essential groundwater management function in this valley.

The typical nitrate concentration range in the principal aquifer of the Santa Clara Valley Subbasin is 13 to 16 mg/L, indicating that anthropogenic contamination is present. The maximum nitrate concentration detected in this zone was 43 mg/L in 2002 and 40 mg/L in 2003. Nitrate concentrations in the upper aquifer zone of the Santa Clara Valley Subbasin are typically between 2 and 12 mg/L. District staff concludes that the higher nitrate concentrations in the principal aquifer zone are the result of historic nitrate sources, rather than ongoing nitrate sources. If ongoing nitrate sources were contributing to nitrate concentrations, then nitrate concentrations in the upper aquifer zone would likely be higher. Nitrate concentrations in this subbasin appear to be stable, though high concentrations of nitrate are noted in some areas.

The typical nitrate concentration range for the Coyote Subbasin is 10 to 47 mg/L. In 2002, about one-fourth of the wells (5 of 23) monitored contained nitrate concentrations in excess of the drinking water standard, and nitrate concentrations were elevated in the remaining wells. In 2003, about one-third of the wells (4 of 11) contained nitrate concentrations in excess of the drinking water standard, and nitrate concentrations were elevated in the remaining wells. The wells with nitrate concentrations above the drinking water standard are located in the southern half of the subbasin. The primary land uses in the subbasin are agricultural and rural residential.

The typical nitrate concentration range for the upper aquifer zone of the Llagas Subbasin is 16 to 46 mg/L. The typical nitrate concentration range for the lower principal aquifer zone is 25 to 34 mg/L. The data indicate anthropogenic contamination in both aquifer zones. In 2002, in the principal aquifer zone, 20 of 71 wells contained nitrate concentrations above the drinking water standard, and 8 of 33 wells in the upper aquifer zone contained nitrate concentrations above the drinking water standard. In 2003, in the principal aquifer zone, 15 of 84 wells contained nitrate concentrations above the drinking water standard, and 6 of 12 wells in the upper aquifer zone contained nitrate concentrations above the drinking water standard. Current land uses in the subbasin are varied, with urban areas in the cities of Gilroy and Morgan Hill and rural areas in the remainder of the subbasin.

In 2002 and 2003, the drinking water standard for nitrate was exceeded in more wells than any other constituent, and elevated nitrate concentrations were observed throughout the groundwater subbasins. Figures 5-9 and 5-10 show the relative nitrate concentrations in the principal aquifer zones of the groundwater subbasins in 2002 and 2003, respectively. The District began implementing a nitrate management program in 1992. The program was first implemented to address increasing nitrate concentrations in the Llagas Subbasin, but has since been expanded Countywide. The current program consists of nitrate monitoring and efforts to reduce exposure and to reduce nitrate loading. Staff is also researching options for reducing nitrate concentrations in groundwater.

5.2.1 Nitrate Monitoring

The District began regular monitoring of nitrate in the Coyote and Llagas Subbasins in February 1999. Samples are collected from a total of approximately 55 wells in both the upper and principal aquifer zones. Quarterly monitoring was performed in 1999 and 2000. Statistical analyses of data collected in that time period indicated that concentrations were stable in most wells and that concentration changes between quarters were not significant so the sampling interval was reduced. The District monitored nitrate concentrations biannually, in the spring and fall, from 2001 through 2003. Statistical analysis of the data did not reveal significant differences between seasons.

Staff also performed a statistical comparison of nitrate concentrations in 1988 to concentrations in 1998. In 1988, the County of Santa Clara performed an extensive well water testing program for nitrate, which included sampling over 450 wells. The District performed a similar testing program in 1998, in which over 600 wells were tested. The difference in median nitrate concentrations in the Coyote Subbasin was statistically insignificant. However, the difference in the Llagas Subbasin was statistically significant, with the median concentration increasing from 41 mg/L to 47.1 mg/L.

In 2002, the North Santa Clara County Nitrate Study evaluated nitrate occurrence and trends in the principal aquifer zone of the Santa Clara Valley Subbasin in response to public water supplier concerns about nitrate concentrations in some wells. The results of the data evaluation indicated that nitrate concentrations in the subbasin appeared to have declined from 1984 to 2000. Although some individual wells showed increasing trends in concentrations, 91 percent of the wells showed no apparent trend or a decrease in nitrate concentrations.

5.2.2 Nitrate Exposure

To reduce exposure to nitrate, the District offers a free nitrate analysis to all private water supply well owners. Since 1998, over 600 tests have been conducted. More than half the wells tested have exceeded the MCL of 45 mg/L. Test recipients are given a copy of the results along with a fact sheet detailing what nitrate is, where it comes from, what the health risks are, how to remove nitrate using point-of-use treatment systems, and how to prevent groundwater contamination.

5.2.3 Nitrate Loading

The District conducts public outreach and education, works with other agencies, and provides direct technical assistance to growers through the Irrigation and Fertilizer Management Program.

Outreach and Education

District staff prepared and distributed fact sheets on irrigation and nutrient management, wells, and septic systems in 2002. District staff also conducted seminars and workshops on irrigation and nutrient management and groundwater protection at horse and rural residential properties.

In March 2003, the District observed Groundwater Awareness Week. The District posted additional groundwater information on its web site, mailed postcards on groundwater protection and well water testing to registered private well owners, and included information on obtaining groundwater-related resources on its telephone system “hold” messages.

District staff provided basic groundwater protection and nitrate management information to local residents at a small acreage workshop sponsored by the Loma Prieta Resource Conservation District in October 2003. The District sponsored 2 growers meetings in 2003. The meetings included presentations on irrigation and fertilization, and use of soil moisture measurement devices. A drip fertigation workshop was also held in the summer of 2003.

Coordination with Other Agencies

Staff also coordinates with other agencies, including the Regional Water Quality Control Boards (Regional Boards) and Santa Clara County Department of Environmental Health, to provide input on implementing their regulations to protect local groundwater resources. These agencies are involved in regulating septic systems and wastewater discharges.

Irrigation and Fertilizer Management Program

The District also sponsors the Irrigation and Fertilizer Management Program (IFMP). This program provides free testing of agricultural pumps and irrigation systems, irrigation scheduling consultation, and testing and consultation in plant nutrient status and fertilizer management for three years. The program's objectives are to increase water and nutrient use efficiencies and reduce nitrogen fertilizer loading to groundwater.

The District works with consultants to provide growers with an irrigation system evaluation with recommendations for irrigation schedules to minimize fertilizer leaching. Services include collecting and analyzing plant samples and well water samples throughout the growing season to determine the optimum fertilization schedule for the plants and to determine if the plants require additional nutrients other than nitrate.

IFMP services were provided to 23 growers collectively farming about 40 fields in 2003. IFMP has been well received because growers participating in the program:

- Qualify for the State Water Resources Control Board's conditional waivers of agricultural discharges
- Qualify for a $2 per acre-foot discount on the groundwater withdrawal fee, in addition to a $2 per acre-foot discount for participating in the irrigation management portion of the program.

5.3 Volatile Organic Chemicals

Volatile organic chemicals (VOCs) are used in a variety of commercial, industrial, and manufacturing activities, including gasoline stations, circuit board manufacturing, dry cleaning, semiconductor manufacturing, automotive repair, and numerous others. While they rarely constitute a significant mass of the total dissolved solids due to solubility limitations, some can cause serious health effects at very low concentrations. Organic substances most commonly affect shallow upper aquifer zones and originate from improper disposal practices, releases from underground storage tanks, or from accidental spills or leaks. Monitoring for volatile organic contamination is crucial, because widespread contamination at even low concentrations could drastically limit groundwater subbasin use. The VOCs with drinking water standards or for which monitoring is required by DHS regulations are listed in Table 5-1. Analyses of additional VOCs, those typically reported with approved drinking water analytical methods, were performed by the District and public water suppliers. Staff reviewed the results of all VOC analyses and the results are discussed below.

The VOC monitoring results discussed here are based on samples collected by the District as part of its basinwide groundwater monitoring program or by public water suppliers as part of their Title 22 compliance monitoring, unless otherwise noted. Groundwater monitoring for VOCs is also routinely performed at contamination sites. However, those site-specific data are not reported here, as they are too voluminous and do not reflect basinwide groundwater quality conditions.

In 2002, VOCs below drinking water standards were detectable in a total of 22 wells. One of these wells is an upper zone monitoring well in the Santa Clara Valley Subbasin. The remaining 21 wells are active water supply wells in the principal aquifer zones, with two in the Llagas Subbasin, one in the Coyote Subbasin and 18 in the Santa Clara Valley Subbasin. The most commonly detected VOCs was 1,1,1-trichloroethane (1,1,1-TCA), which was detected in 15 wells. A summary of VOC detections in 2002 is provided in Table 5-3.

In 2003, VOCs below drinking water standards were detectable in a total of 20 wells. In the principal aquifer zone of the Santa Clara Valley Subbasin, one of these wells was an agricultural well and one was a monitoring well. In the upper aquifer zone of the Llagas Subbasin, one well was a monitoring well. The remaining 17 wells were active water supply wells in the principal aquifer zones; two in the Llagas Subbasin and 15 in the Santa Clara Valley Subbasin. The most commonly detected VOC was 1,1,1-TCA detected in 13 wells. A summary of VOC detections in 2003 is provided in Table 5-4.

Although all VOC detections were below drinking water standards, VOCs are still a concern. VOC detections in the principal aquifer zones indicate that VOC contamination has migrated from surface and near surface sources to deeper water supply aquifers, indicating a migration pathway for contamination to move into the principal aquifers. Although VOCs have been detected in deeper water supply aquifers, low concentrations and relatively few detections indicate that the regulatory programs designed to ensure VOC contamination sites are properly investigated and cleaned up have essentially been successful in protecting the groundwater subbasins from contamination. These programs are described below.

5.3.1 Solvents and Toxics Liaison Program

The District conducts the Solvents and Toxics Liaison Program, which addresses VOC and other types of toxic contamination. The high density of dry cleaners and electronics manufacturing plants in some parts of Santa Clara County, together with heavy industry and military facilities, has resulted in several hundred known VOC release sites impacting shallow groundwater. The District provides peer review and tracks the progress of these sites, and sites with other toxic releases, to ensure that water resources are protected.

District staff works closely with both Regional Water Quality Control Boards, the California Department of Toxics Substances Control and Federal EPA in responding to investigation and cleanup actions undertaken at some of the highest risk toxics sites in the County. To date, over 700 solvents and toxic sites have been reported in the County. There are approximately 200 active cases, 200 inactive cases, 200 closed cases, and 100 other status type cases (Figure 5-11).

The District continues to monitor cleanup progress at active sites and works with the regulatory agencies to resolve the inactive and other status type cases. Staff is performing a study of the historic locations of over 1,000 dry cleaners in Santa Clara County to determine how many potential sources of dry cleaner contamination are present in the Santa Clara Valley Subbasin, and to rank them with respect to their potential to degrade groundwater quality.

5.3.2 Leaking Underground Storage Tank Oversight Program

Since 1988, the District has overseen the investigation, cleanup, and closure of cases where soil and/or groundwater have been affected by petroleum fuel and additives such as MTBE from leaking underground storage tank (UST) systems. More than 2,430 leaking UST cases have been reported in the County. Of the 2,430 leaking UST cases, 76 percent have been closed, but investigation and cleanup activities are ongoing at more than 500 active cases. Groundwater has been impacted at nearly all the active cases (90 percent) and MTBE has been detected at about 75 percent of those cases. Most of the contamination associated with these sites has been limited to the upper aquifer zone. However, MTBE contamination has caused impacts in two public water supply wells.

MTBE is an ongoing concern for the District. Field studies performed by the District and others show that undetected releases continue to occur at up to

60 percent of operating gasoline tank facilities. In accordance with a District request, the RWQCBs require environmental monitoring at operating gasoline UST facilities that pose the greatest threat to groundwater resources. Over 150 facilities have been requested to conduct investigations of MTBE presence in groundwater. This work is almost complete and the project is viewed as a success. Many facilities were found to have significant MTBE contamination and would have otherwise remained unknown. Sites with evidence of releases were added to the Local Oversight Program (LOP) for investigation and cleanup oversight. Staff will continue to communicate information about the ongoing threat to groundwater resources from MTBE and other additives in gasoline.

In March 2002, the Governor of California extended the phase-out date for MTBE to 2004. The phase out was effective at the start of 2004. The District prioritizes fuel leak cases that pose the greatest risk to the groundwater subbasin and ensures that immediate action is taken to address the sites which have the greatest potential for contamination of the water wells and vulnerable portions of the groundwater subbasins. Due to the number of closures, successful cleanup and phase out of MTBE from gasoline in California, most of the remaining open cases are relatively low risk compared to other groundwater contaminant issues. Therefore, the District will be transitioning the fuel leak oversight to the County of Santa Clara. This transition will occur in 2005, and will allow the District more flexibility in allocating resources to high priority groundwater issues. Staff will continue to provide vigilant oversight to leaking UST sites for the short term and will coordinate high priority case oversight with the County.

5.4 Synthetic Organic Chemicals

Non-volatile synthetic organic chemicals (SOCs) include pesticides, dioxin, polychlorinated biphenyls (PCBs), and chemical manufacturing discharges. Pesticides are designed to be poisonous to one or more organisms, and many pose a threat to human health. Most pesticides currently permitted for use in California break down quickly in the environment or pose a low risk to human health and the environment. Some toxic and more mobile pesticides are still in use and other historically used toxic and persistent pesticides may remain in the environment. The California Department of Pesticide Regulation monitors groundwater throughout the state for pesticides. In addition, public water suppliers are required to monitor for pesticides. Other SOCs of concern, most notably dioxin and PCBs, are also very toxic. Dioxin has a drinking water standard of 0.00003 ug/L.

Public water suppliers sampled 70 wells for one or more SOCs during 2002 and approximately 65 wells during 2003. The SOCs with a drinking water standard are listed in Table 5-1. Only one SOC was detected, di(2-ethylhexyl)phthalate at 4.5 ug/L in one well, which is located in the Santa Clara Valley Subbasin principal aquifer zone (Table 5-5). The drinking water standard for di(2-ethylhexyl)phthalate is 4 ug/L. In 2003, no SOCs were detected.

5.5 Unregulated Chemical Monitoring Requirements

DHS regulations (Title 22 California Code of Regulations Section 64450) required community water systems and non-transient and non-community water systems to complete analyses for unregulated chemicals by December 31, 2003. Unregulated chemicals for which monitoring is required are being considered for regulation. The District sampled wells in areas without public water system wells for unregulated chemicals requiring monitoring in 2003. This section presents a summary of the 2003 sampling results for unregulated chemicals, including both public water system sampling results and District sampling results. Table 5-6 lists the unregulated chemicals requiring monitoring.

No detectable level of any organic unregulated chemical was detected in groundwater throughout the County. Several inorganic unregulated chemicals were present in detectable concentrations. However, the concentrations were generally low. One area of potential concern was identified where hexavalent chromium is somewhat elevated. This area is known as the Coyote Narrows, the affected wells lie just north of Metcalf Road and just east of Monterey Highway. Perchlorate was detected in numerous wells, as described in the next section.

5.5.1 Perchlorate

Perchlorate is an oxygenated anion, with both natural and anthropogenic sources, made up of four oxygen atoms and one chlorine atom. It forms salts in the presence of cations such as potassium, ammonium, and sodium. Common uses of perchlorate are as an oxidizer in rocket propellant, safety flares, slurry explosives, and air bag inflators. Perchlorate is soluble in water. Once in water, it is very mobile and can persist for decades. Perchlorate can interfere with thyroid function. The thyroid gland regulates the release of hormones for growth, development, and metabolism. The California Office of Health Hazard Assessment established a Public Health Goal (PHG) for perchlorate of 6 ug/L on March 11, 2004. The California Department of Health Services is in the process of establishing a drinking water standard for perchlorate. The DHS Action Level, which is an advisory level for notification of contamination, is 6 ug/L perchlorate.

The District and public water suppliers collected samples for perchlorate analyses from 169 wells in 2003. Public water suppliers collected 111 of the samples and the District collected 58 samples to complement public water supply well testing. Perchlorate was detected in 10 wells, at concentrations ranging from 4.0 to 8.0 ug/L. Five of the wells with detections are public water supply wells and the remaining five wells are private water supply wells or monitoring wells.

Llagas Subbasin Perchlorate Occurrence

Perchlorate has been detected over a wide area of the Llagas Subbasin, apparently originating from a former safety flare manufacturing facility in Morgan Hill. Nearly 1,300 water supply wells in the Llagas Subbasin were tested for perchlorate in 2003. Perchlorate was detected in nearly 800 of those wells, with concentrations ranging from at the detection limit to 100 ug/L, though perchlorate concentrations were at or below 10 ug/L in all but 10 of the wells.

The flare manufacturing facility is known as the Olin/Standard Fusee site and is located at 425 Tennant Avenue, Morgan Hill. Safety flares were manufactured at the site from 1956 to 1996. The site was demolished in 1998. At that time, perchlorate had not been identified as a contaminant of concern. However, perchlorate was detected in 2000 during a due diligence investigation by a potential property buyer. The Central Coast Regional Water Quality Control Board, the regulatory authority for investigation and cleanup at the site, requested further investigation and testing of the City of Morgan Hill's Tennant Avenue well, located across the street from the Olin site. Perchlorate was detected in the Tennant Avenue well in March 2002. Olin conducted offsite testing of private wells beginning in June 2002. Perchlorate was detected in private wells up to one mile south of the Olin site in November 2002. In December 2002, the District sampled 15 of its monitoring program wells in the Llagas Subbasin. The results of this sampling, which were received in January 2003, showed perchlorate up to 4.3 miles south of the Olin site.

In January 2003, the District initiated a free well testing and bottled water service program for private well owners in the affected area. As a result of the District's sampling program, Olin's ongoing efforts to characterize the plume, and public water supply well testing, perchlorate data is available for nearly 1,300 water supply wells. As stated above, perchlorate has been detected in nearly 800 wells in concentrations up to 100 ug/L. Perchlorate has been detected at or above the Public Health Goal of 6 ug/L in more than 200 wells. The plume extends approximately 10.5 miles south of the Olin site. The maximum concentrations of perchlorate detected in the Llagas Subbasin through March 2004 are illustrated in Figure 5-12.

Olin is continuing to test wells and performs quarterly groundwater monitoring. However, the plume has not yet been fully characterized. Additional sampling is needed to characterize the southern and northern extents of the plume and to characterize the vertical distribution of perchlorate. Olin has not yet installed off-site monitoring wells, which is contributing to concerns over vertical characterization.

Olin began onsite groundwater cleanup in spring 2004, and is in the process of initiating soil cleanup. However, they have not yet submitted long-term groundwater cleanup plans for the entire plume. The City of Morgan Hill has installed treatment systems on two of their wells that have been affected by perchlorate and is operating one of those wells. Olin has installed treatment systems on wells owned and operated by the San Martin County Water District and the West San Martin Water Works, which serve a total of approximately 450 connections. Still, thousands of residents continue to rely on bottled water for their

District involvement with perchlorate issues

- Supporting research on effective technologies for removing perchlorate at the wellhead
- Continued groundwater monitoring of perchlorate, other water quality parameters, and water levels
- Obtaining federal funding to find and implement solutions to the perchlorate contamination (in 2004, $25 million was obtained through Senate Bill HR 4459)
- Web site posting of perchlorate information, updates, and technical reports
- Analyzing and commenting on technical report submittals from Olin to the Regional Water Quality Control Board
- Identifying appropriate technical actions necessary to fully address the perchlorate problem
- Providing technical and administrative support to the Regional Board and the Perchlorate Community Advisory Group
- Seeking legislation to improve the Regional Board's and the District's ability to meet the community's expectations

drinking water supply. Olin completed an evaluation of long-term water supply alternatives in April 2004, but proposes waiting until there is a drinking water standard for perchlorate to implement solutions.

The District is continuing to work with the rest of the community, including the cities of Morgan Hill and Gilroy, County of Santa Clara, Central Coast Regional Water Quality Control Board, the Perchlorate Community Advisory Group, and legislators on several efforts.

The District's goal in these efforts is to ensure that the community's needs for water supply and groundwater cleanup are addressed quickly and at minimal local cost.

5.6 Radiological Constituents

No well contained radiological constituents above drinking water standards for 2002 or 2003.

5.7 Groundwater Quality Summary

Overall groundwater quality in Santa Clara County is very good and water quality objectives are met in almost all wells. The most significant exception is nitrate, which continues to be a concern in the Llagas and Coyote Subbasins. The nitrate drinking water standard was exceeded in 33 wells in 2002 and 39 wells in 2003. Some of these are upper aquifer zone monitoring wells and others are agricultural supply wells. The drinking water standard for nitrate was exceeded in 25 wells whose primary use is municipal or domestic supply in 2002 and 19 wells in 2003. The District continues to implement a comprehensive nitrate management program to reduce nitrate exposure, reduce nitrate loading, and monitor groundwater quality.

Drinking water standards for other inorganic constituents were exceeded in 48 wells in 2002 and 44 wells in 2003. All these exceedences were for naturally occurring constituents and all but one was for secondary drinking water standards. Secondary standards are based on protecting consumers from adverse tastes, odors, or appearance. Such exceedences do not pose a health risk. The primary, health-based drinking water standard for aluminum was exceeded in one drinking water supply well in 2002. No wells used for agricultural supply exceeded agricultural water quality objectives. The only wells which exceeded agricultural water quality objectives were not agricultural water supply wells. In 2002, 14 wells and in 2003, 13 wells exceeded the agricultural water quality objectives for boron. One well in 2002 exceeded the agricultural water quality objective for selenium.

VOCs were detected below drinking water standards in 22 wells in 2002 and 20 wells in 2003. One SOC, di(2 ethylhexyl)phthalate, was detected in 2002 above its primary drinking water standard in one drinking water supply well in the Santa Clara Valley Subbasin.

District Board Ends Policy directs staff to ensure "The groundwater basins are aggressively protected from contamination and the threat of contamination." The Chief Executive Officer's interpretation of this policy is "Index wells should not have contaminant concentrations that exceed water quality objectives". The data summarized in this report show that groundwater management programs essentially achieve the desired end. The District continues monitoring groundwater quality and collecting public water supply well data from DHS.

Table 5-1

Groundwater Constituents Sampled in 2002 and 2003

Inorganic Constituent Group (including nitrate)

- Alkalinity
- Aluminum
- Arsenic
- Barium
- Bicarbonate
- Boron
- Bromide
- Cadmium
- Calcium
- Chloride
- Chromium
- Copper
- Fluoride
- Hardness
- Iron
- Lead
- Magnesium
- Manganese
- Mercury
- Nickel
- Nitrate
- Potassium
- Selenium
- Silica
- Silver
- Sodium
- Sulfate
- Total Dissolved Solids
- Turbidity
- Zinc

Volatile Organic Chemicals (VOCs)

- Benzene
- Bromodichloromethane (THM)
- Bromoform (THM)
- Carbon Tetrachloride
- Chloroform (THM)
- Dibromochloromethane (THM)
- 1,2-Dichlorobenzene
- 1,4-Dichlorobenzene
- Dichlorodifluoromethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1-Dichloroethylene
- cis-1,2-Dichloroethylene
- trans-1,2-Dichloroethylene
- Dichloromethane
- 1,2-Dichloropropane
- 1,3-Dichloropropene
- Ethyl tertiary butyl ether
- Ethylbenzene
- Methyl tertiary butyl ether
- Monochlorobenzene
- Styrene
- Tertiary amyl methyl ether
- Tertiary butyl alcohol
- 1,1,1,2-Tetrachloroethane
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethylene
- Toluene
- Total Trihalomethanes (TTHMs)
- 1,2,4-Trichlorobenzene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Trichloroethylene
- Trichlorofluoromethane
- 1,2,3-Trichloropropane
- 1,1,2-Trichloro-1,2,2-Trifluoroethane
- Vinyl Chloride
- Xylenes (Total)

Synthetic Organic Chemicals (SOCs)

- Alachlor
- Atrazine
- Bentazon
- Benzo(a)pyrene
- Carbofuran
- Chlordane
- 2,4-D
- Dalapon
- Dibromochloropropane (DBCP)
- Di(2-ethylhexyl)adipate
- Di(2-ethylhexyl)phthalate
- Dinoseb
- Diquat
- Endothall
- Endrin
- Ethylene Dibromide (EDB)
- Glyphosate
- Heptachlor
- Heptachlor Epoxide
- Hexachlorobenzene
- Hexachlorocyclopentadiene
- Lindane
- Methoxychlor
- Molinate
- Oxamyl
- Pentachlorophenol
- Picloram
- Polychlorinated Biphenyls
- Simazine
- Thiobencarb
- Toxaphene
- 2,3,7,8-TCDD (Dioxin)
- 2,4,5-TP (Silvex)

Table 5-2

Typical Concentration Ranges for Common Inorganic Constituents*

Constituent	Santa Clara Valley Subbasin		Coyote Subbasin	Llagas Subbasin		Drinking Water Standard[e]	Agricultural Objective[f]
	Principal Aquifer Zone[c]	Upper Aquifer Zone[d]	Principal Aquifer Zone[c]	Principal Aquifer Zone[c]	Upper Aquifer Zone[d]		
Aluminum (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.100	1.0	5.0
Arsenic (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	0.050	0.1
Barium (mg/L)	0.075 to 0.130	0.052 to 0.170	<0.100 to 0.126	<0.100 to 0.254	<0.100 to 0.250	1.0	-
Beryllium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.1
Boron (mg/L)	0.120 to 0.150	0.100 to 0.165	<0.100 to 0.132	<0.100 to 0.108	<0.100 to 0. 284	-	0.5, 0.75 [g]
Bromide (mg/L)	0	0	0	0	0	-	-
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.01
Calcium (mg/L)	67 - 75	49 - 81	37 - 69	40 - 48	41 - 98	-	-
Chloride (mg/L)	40 - 47	35 - 70	17 - 40	22 - 70	32 - 156	600[h]	355
Chromium, Total (mg/L)	<0.010 to 0.002	NA	<0.001 to 0.002	NA	NA	0.050	0.10
Copper (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	1.0	0.20
Fluoride (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	1.7	2
Hardness (mg/L as $CaCO_3$)	262 - 310	192 - 340	180 - 294	215 - 362	184 - 465	-	-
Iron (mg/L)	<0.100	<0.100	<0.100 to 0.700	<0.100 to 0.210	<0.100 to 0.210	0.300[i]	5.0
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	0.015[i]	5.0
Magnesium (mg/L)	25 - 28	16 - 36	22 - 43	25-52	25-64	-	-
Manganese (mg/L)	<0.020	<0.020 to 0.054	<0.020	<0.020	<0.020	0.050	0.2
Mercury (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	-
Nickel (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010 to 0.0 22	0.100	0.2
Nitrate (mg/L as NO_3)	13 - 16	2 - 12	6 - 48	25 - 34	16 - 46	45	135
Selenium (mg/L)	<0.005	<0.005	<0.002 to <0.005	<0.005	<0.005	0.050	0.020
Silver (mg/L)	<0.010	<0.010	<0.001 to <0.010	<0.010	<0.010	0.100	-
Sodium (mg/L)	26.5 - 35	35 - 67	17 - 33	18 - 35	17 - 75	-	-
Specific Conductance (uS/cm)	602 - 691	628 - 954	516 - 625	482 - 685	649 - 1270	2,200[h]	3,000
Sulfate (mg/L)	41 - 46	40 - 67	30 - 60	17 - 68	31 - 113	600[h]	-
Total Dissolved Solids (mg/L)	361 - 440	340 - 500	270 - 430	300 - 630	320 - 740	1,500[h]	10,000
Zinc (mg/L)	<0.050	<0.050	<0.050	<0.066	<0.050	5.0	2.0

Table 5-2

Typical Concentration Ranges for Common Inorganic Constituents Legend

[a] Typical concentration ranges at the approximate 95% Confidence Interval estimate of the true population median.

[c] Principal Aquifer Zone: Aquifer zone from which most water supply wells pump.

[d] Upper Aquifer Zone: Shallow aquifer zone above the regional confining layer in the Santa Clara Valley and Llagas Subbasins.

[e] Drinking Water Standard: Maximum Contaminant Level (MCL) specified in Title 22 of the California Code of Regulations.

[f] Agricultural Objective: Agricultural water quality objective in the 1995 Water Quality Control Plan for the San Francisco Bay Basin, Regional Water Quality Control Board and the 1988 Basin Plan for the California Regional Water Quality Control Board Central Coast Region.

[g] Agricultural Objective for the San Francisco Bay Region is 0.5 mg/l and 0.75 mg/l for the Central Coast Region.

[h] Short-term Maximum Contaminant Level (MCL) as specified in Title 22 of the California Code of Regulations.

[l] Secondary Drinking Water Standard based on customer acceptance limit of taste and/or odor.

[i] Action level. California has not established a MCL for lead. However, there is a 15 ug/L action level for lead. The action level is exceeded if the concentration of lead in more than 10 percent of tap water samples is greater than 15 ug/L.

Nitrate Agricultural Objective: The value listed in the Basin Plan is 30 mg/L NO3+NO2 (as N), which is approximately equivalent to 135 mg/L nitrate as nitrate.

Groundwater Quality

Table 5-3
2002 Volatile Organic Chemical (VOC) Detections

Chemical	Number of Wells with Detections	Maximum Concentration Detected (ug/L)	Drinking Water Standard (ug/L)
Chloroform	2	12	100
Tetrachloroethylene (PCE)	13	2	5
1,1-Dichloroethylene (1,1-DCE)	1	1	6
Toluene	3	1	150
Total Trihalomethanes (TTHMs)	1	1	100
1,1,1-Trichloroethane (1,1,1-TCA)	17	4	200
Trichlorofluoromethane (CCl_3F)	1	4	150
1,1,2-Trichloro-1,2,2-Trifluoroethane (CCl_2F-$CClF_2$)	5	30	1,200

Table 5-4
2003 Volatile Organic Chemical (VOC) Detections

Chemical	Number of Wells with Detections	Maximum Concentration Detected (ug/L)	Drinking Water Standard (ug/L)
Chloroform	3	26	100
Tetrachloroethylene (PCE)	2	1.1	1000
Dichlorodifluoromethane (CCl_2F_2)	2	87	--[1]
Toluene	1	0.71	150
Total Trihalomethanes (TTHMs)	3	2.1	100
1,1,1-Trichloroethane (1,1,1-TCA)	13	2.7	200
1,1,2-Trichloro-1,2,2-Trifluoroethane (CCl_2F-$CClF_2$)	1	18.8	1,200

1 Unregulated chemical for which monitoring is required but there is no Public Health Goal or Maximum Contaminant Level established.

Table 5-5

2002 Synthetic Organic Chemical (SOC) Detections

Chemical	Number of Wells with Detections	Maximum Concentration Detected (ug/L)	Drinking Water Standard (ug/L)
Di(2-ethylhexyl)phthalate	1	4.5	4

Table 5-6

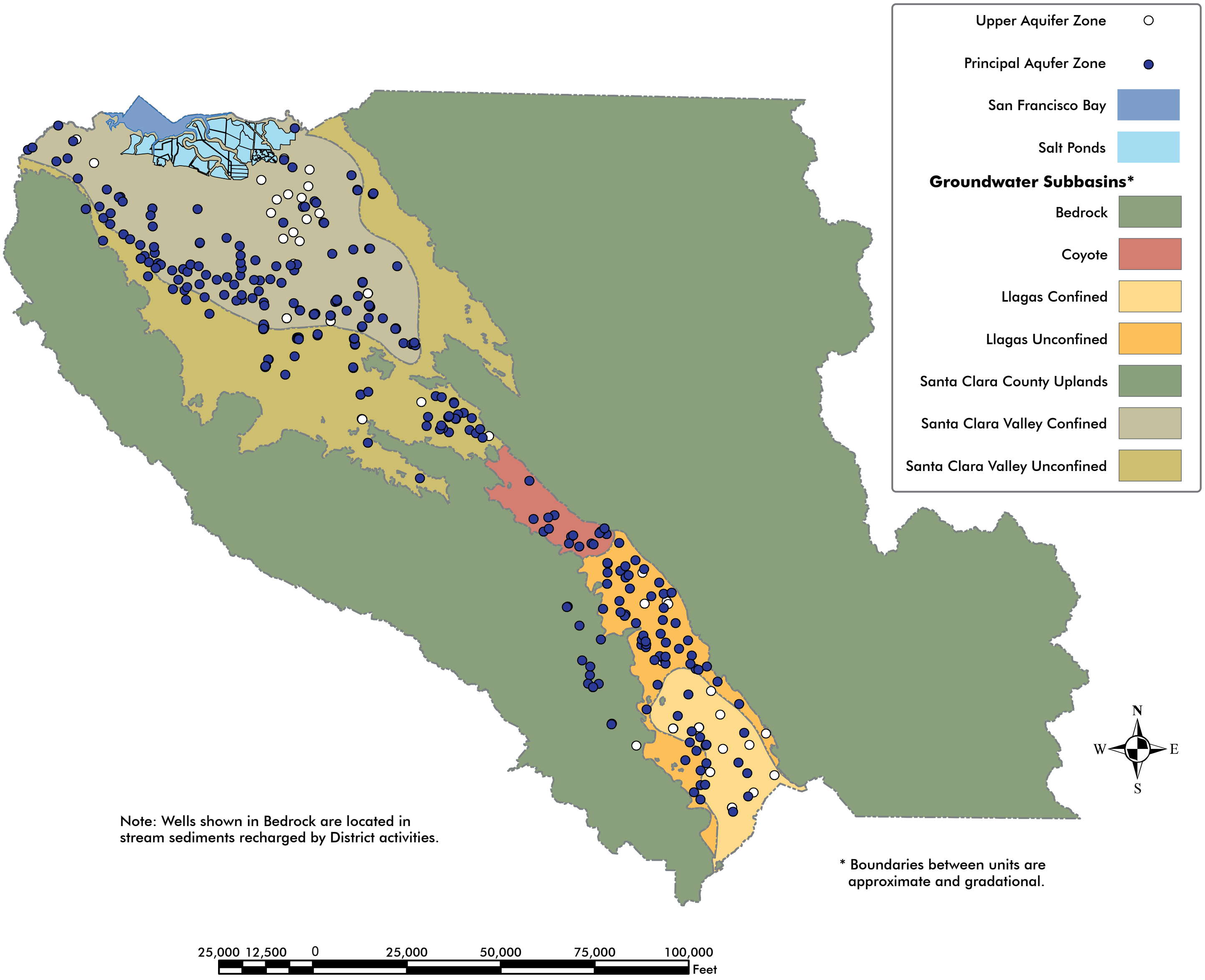
Unregulated Chemicals Requiring Monitoring

Chemical	Type
Dichlorodifluoromethane (Freon 12)	Organic
Ethyl tertiary butyl ether (ETBE)	Organic
Tertiary amyl methyl ether (TAME)	Organic
Tertiary butyl alcohol (TBA)	Organic
1,2,3-Trichloropropane (1,2,3-TCP)	Organic
Boron	Inorganic
Hexavalent Chromium (Chromium-6)	Inorganic
Perchlorate	Inorganic
Vanadium	Inorganic

Groundwater Quality

Figure 5-1

Location of Wells Sampled for Groundwater Quality 2002

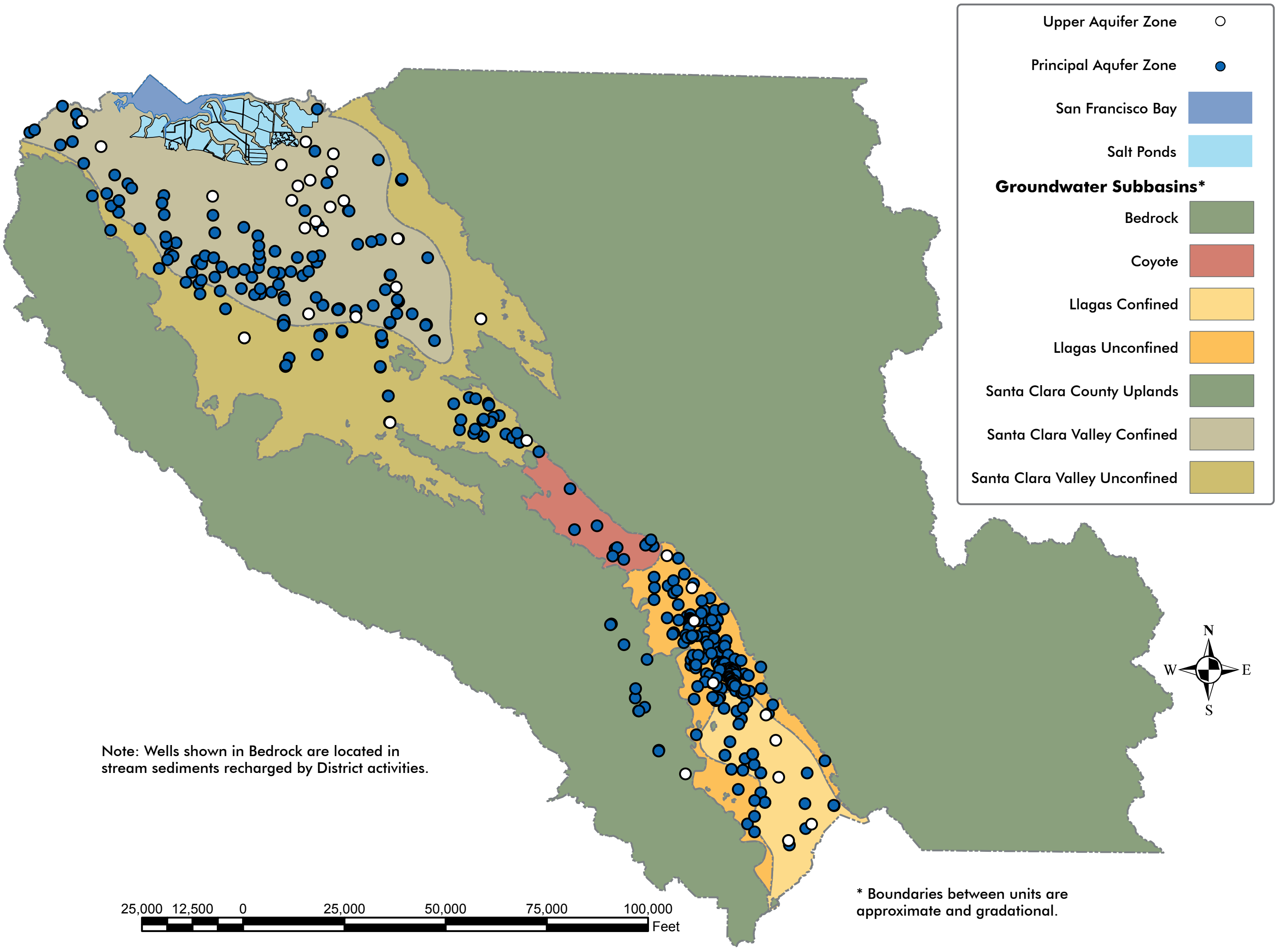


Note: Wells shown in Bedrock are located in stream sediments recharged by District activities.

* Boundaries between units are approximate and gradational.

Figure 5-2

Location of Wells Sampled for Groundwater Quality 2003



Note: Wells shown in Bedrock are located in stream sediments recharged by District activities.

* Boundaries between units are approximate and gradational.

Figure 5-3

Mineral Character of Principal Aquifer Zones in North County 2002

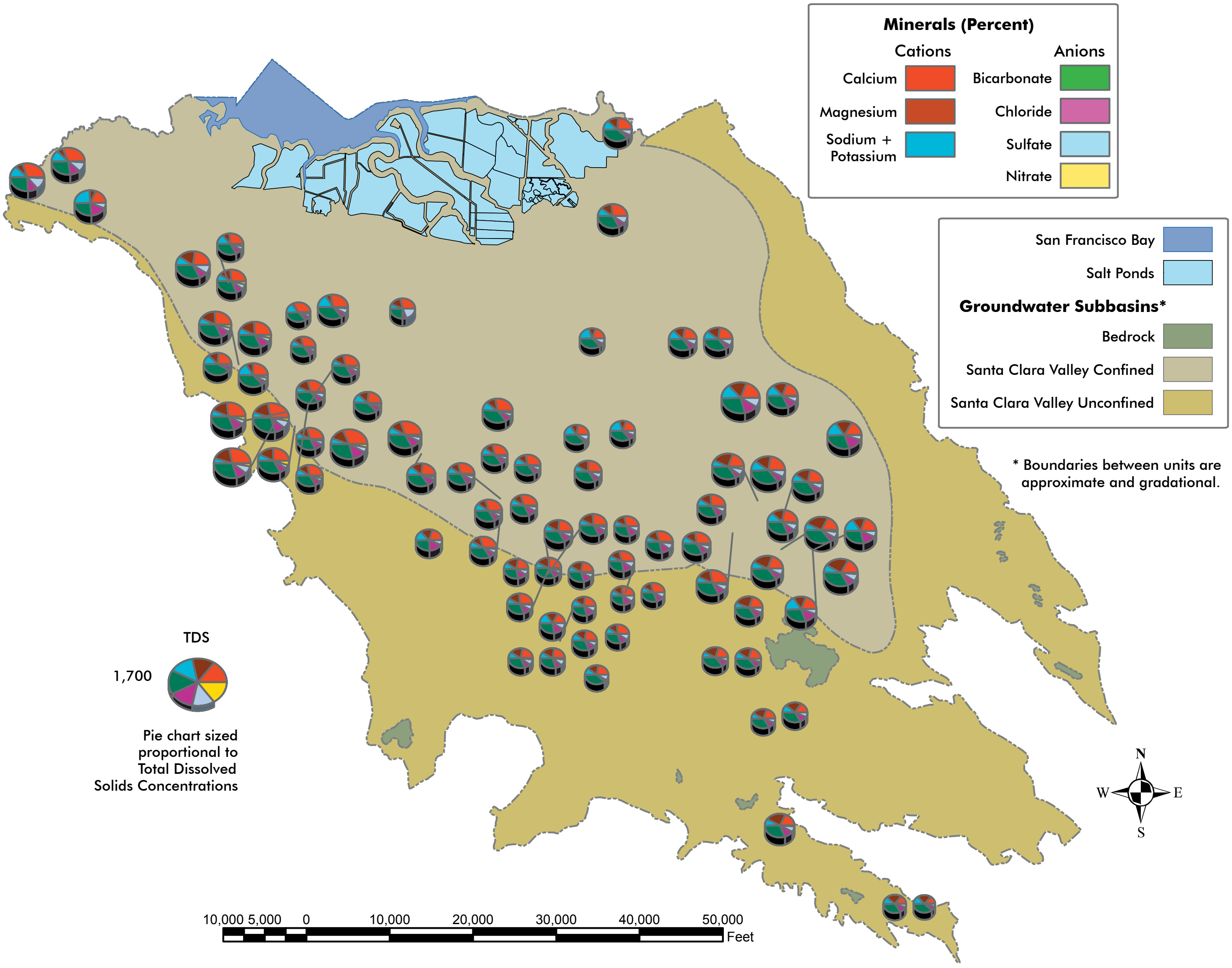
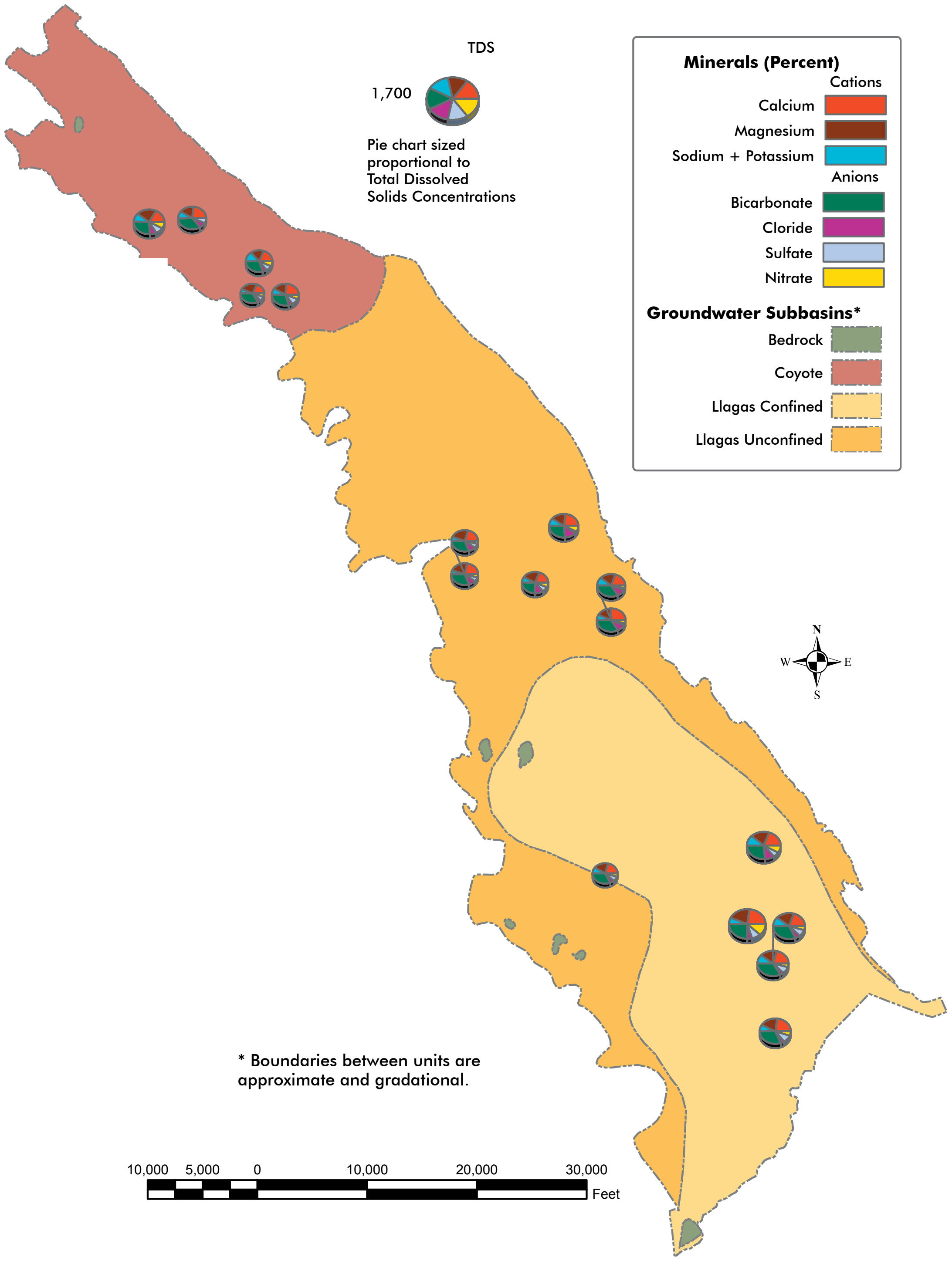


Figure 5-4

Mineral Character of Principal Aquifer Zones in South County 2002



* Boundaries between units are approximate and gradational.

Figure 5-5

Mineral Character of Principal Aquifer Zones in North County 2003

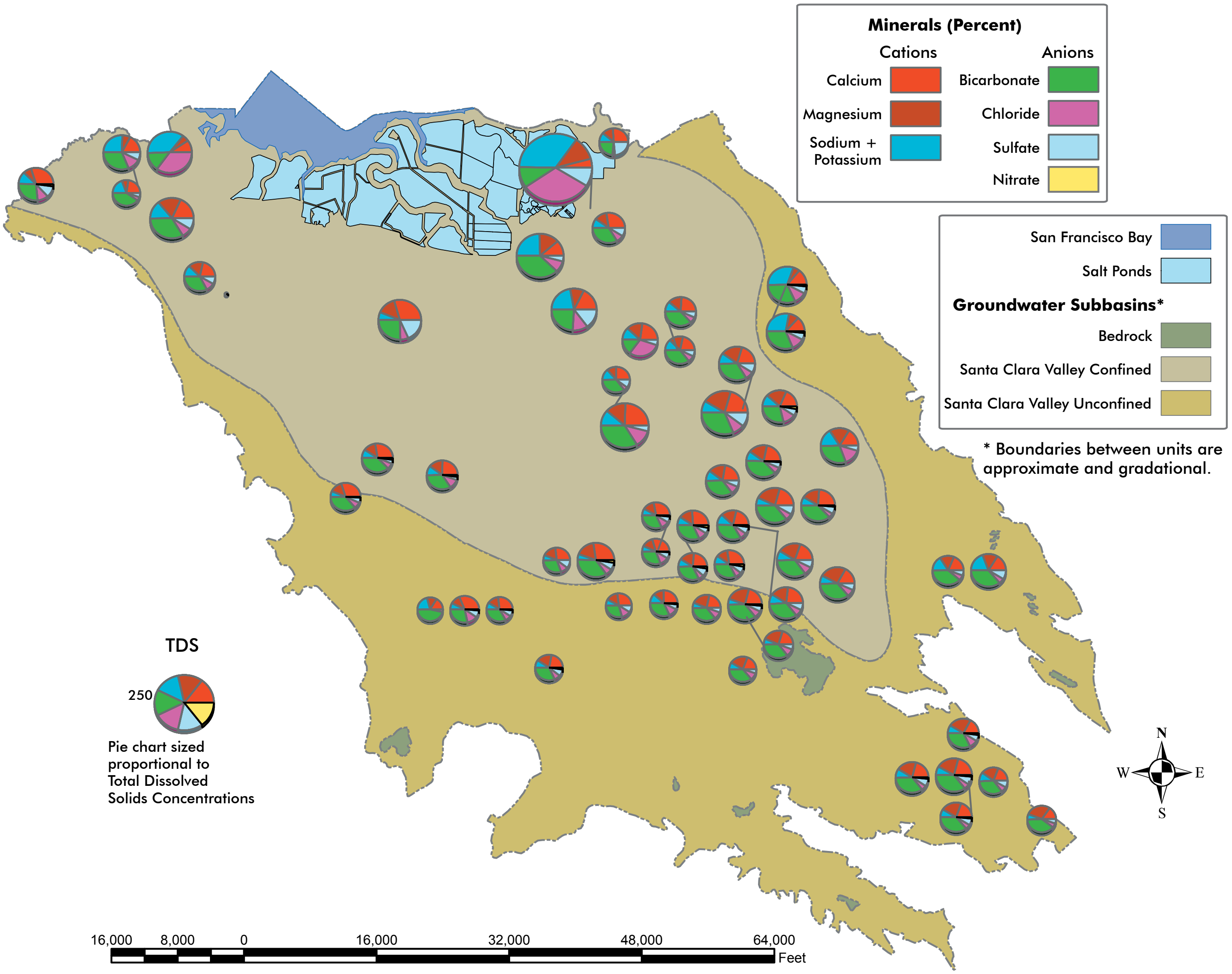
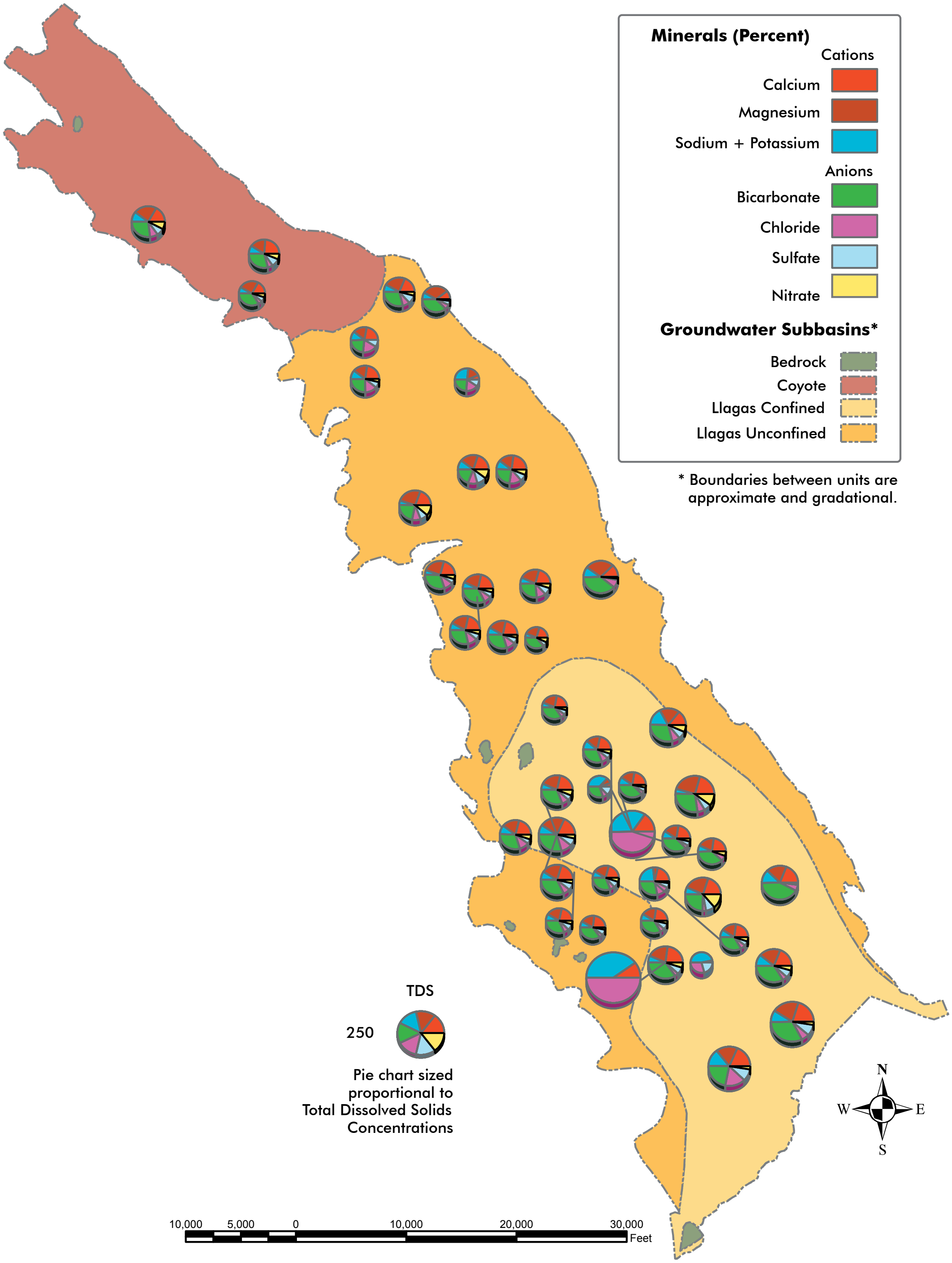


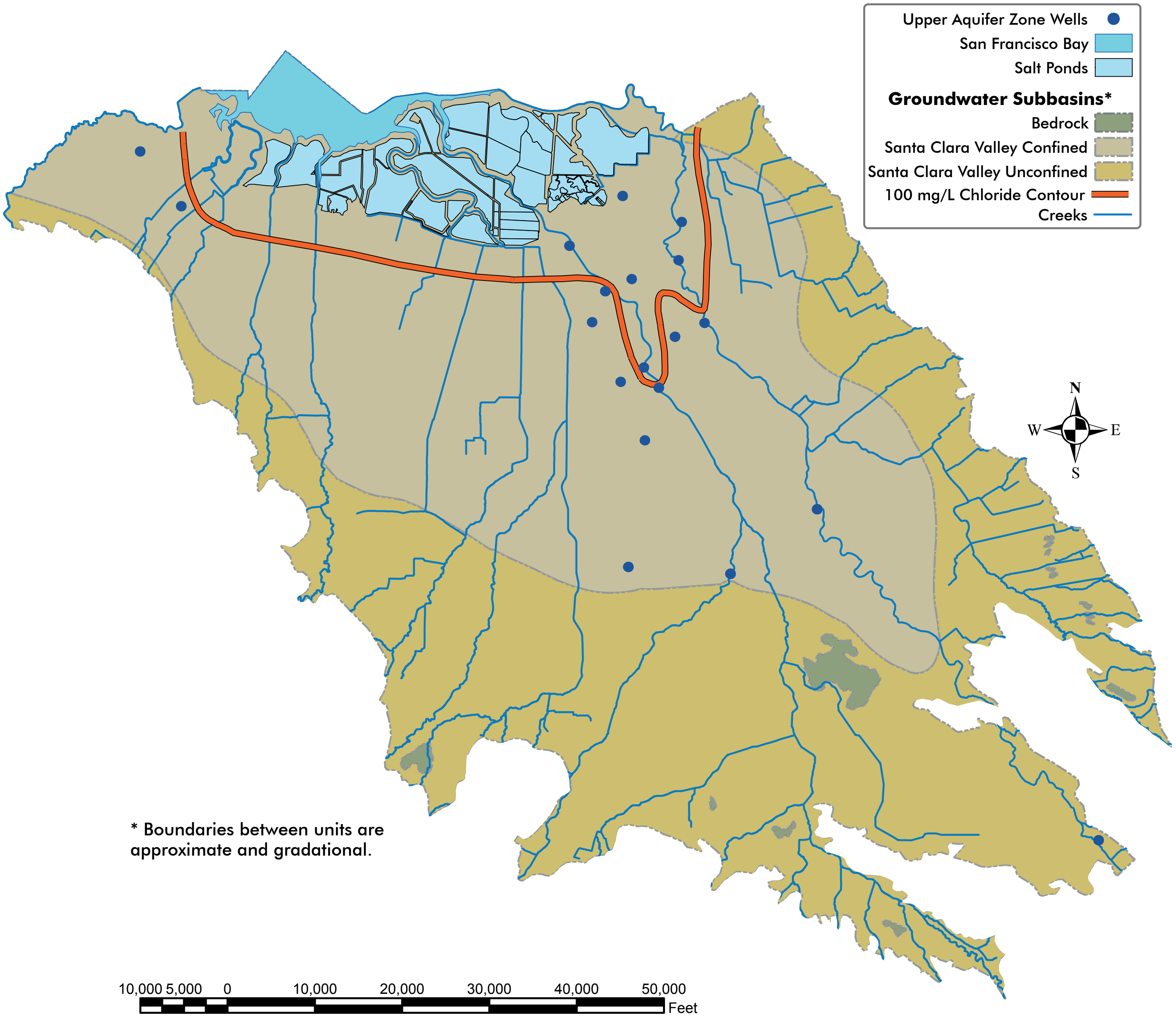
Figure 5-6
Mineral Character of Principal Aquifer Zones in South County 2003



* Boundaries between units are approximate and gradational.

Figure 5-7

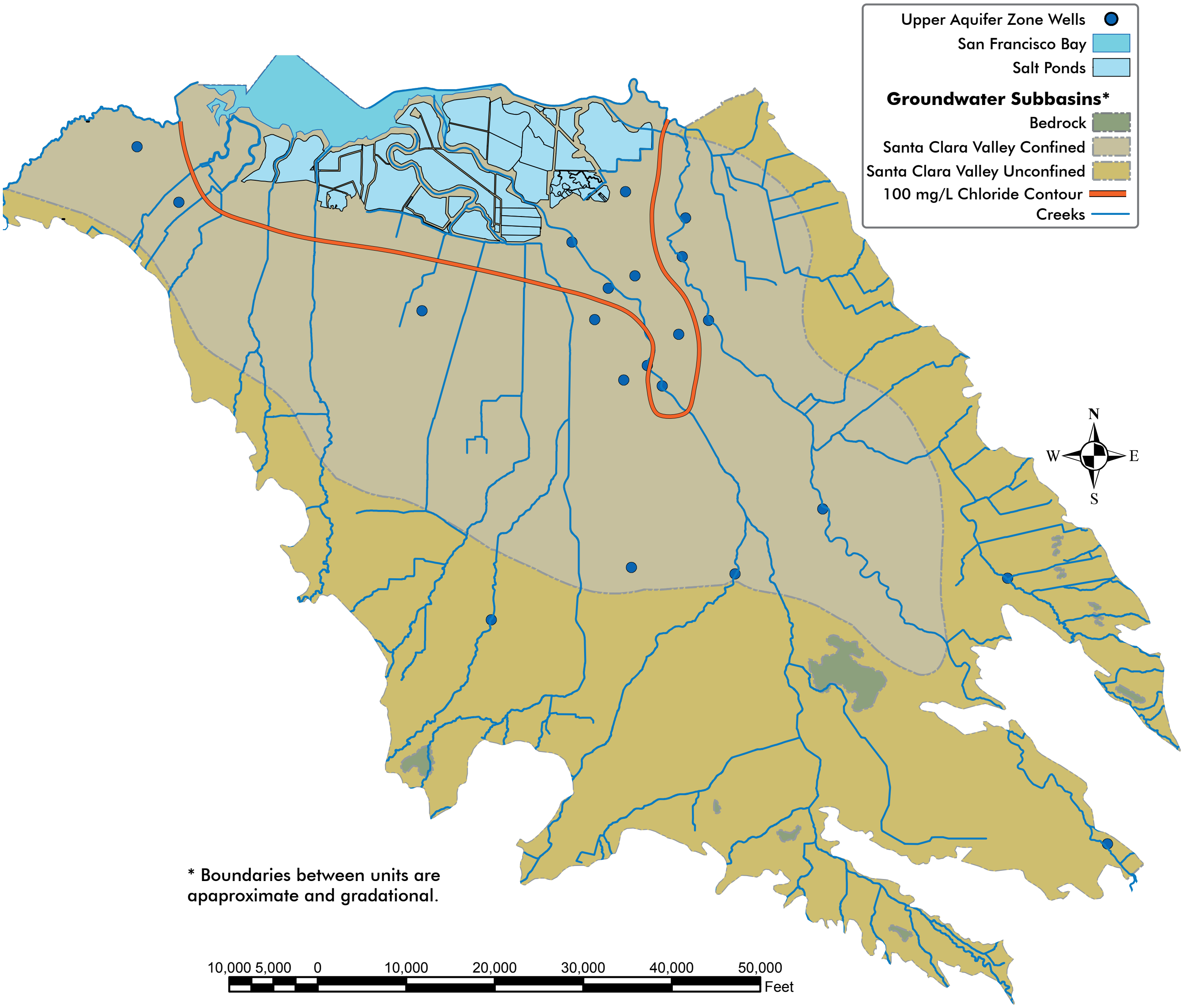
Extent of Salt Water Intrusion in Upper Aquifer Zone 2002



* Boundaries between units are approximate and gradational.

Figure 5-8

Extent of Salt Water Intrusion in Upper Aquifer Zone 2003

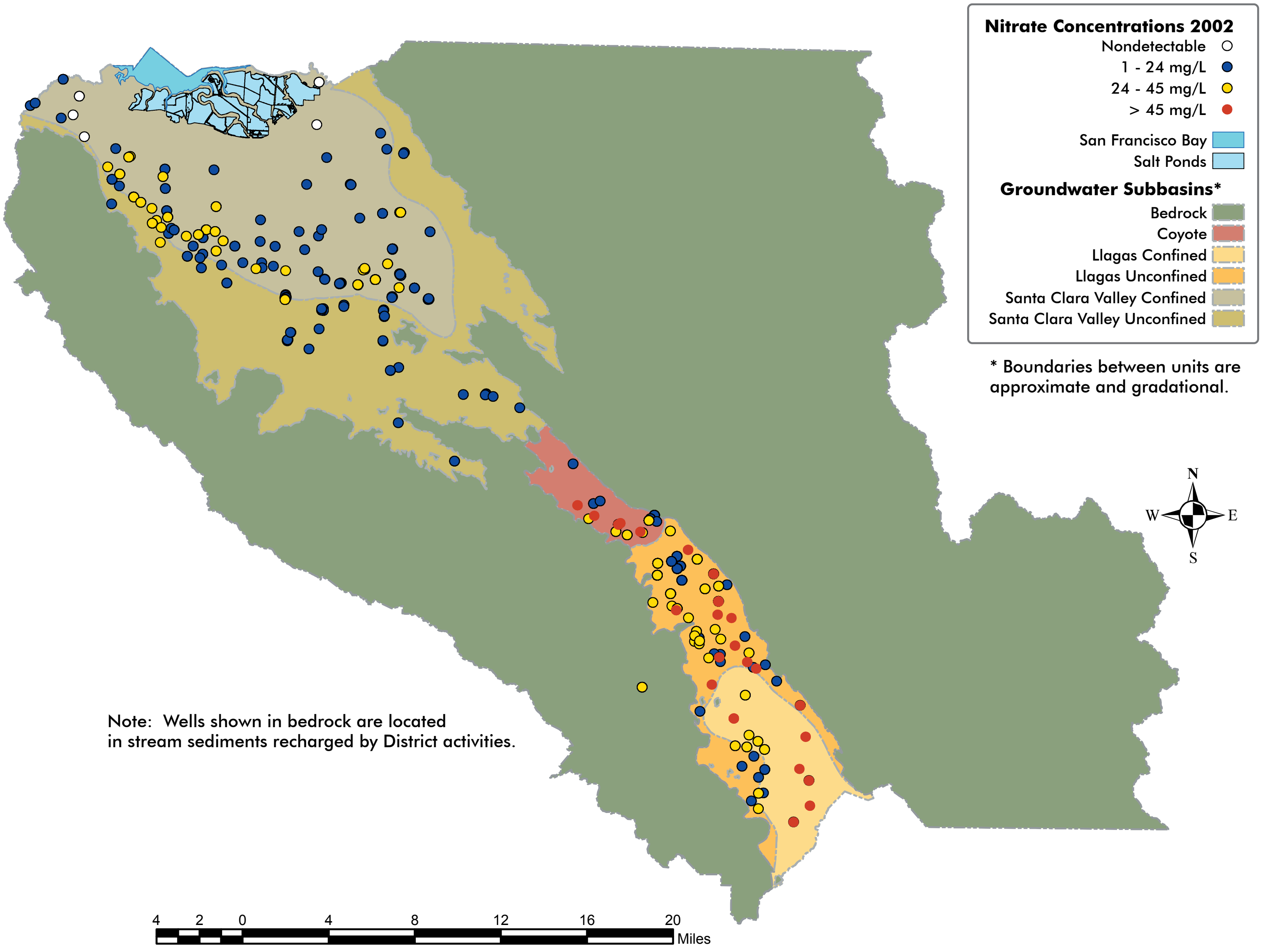


* Boundaries between units are apaproximate and gradational.

Groundwater Quality

Figure 5-9

Nitrate Concentrations in Principal Aquifer Zone 2002

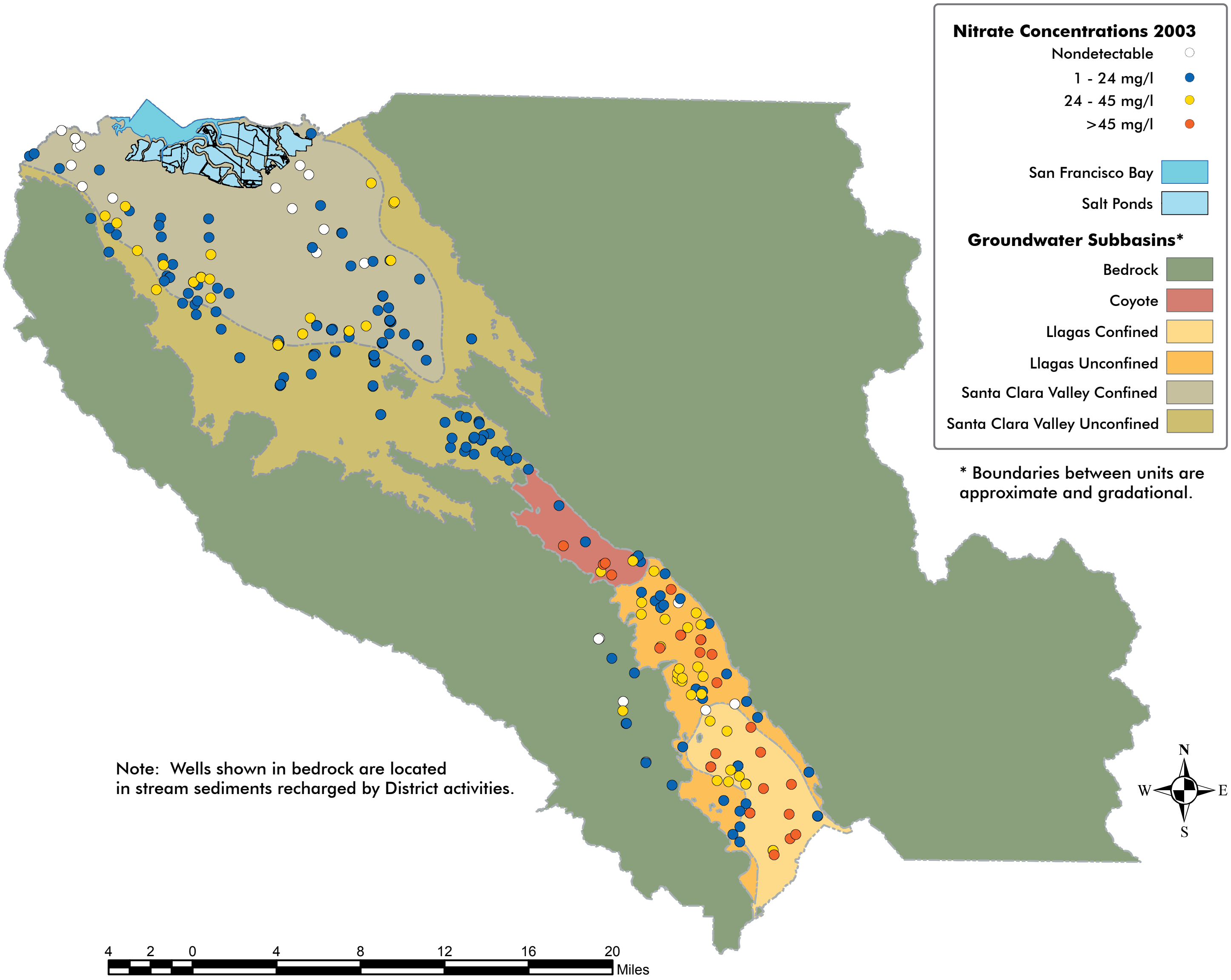


* Boundaries between units are approximate and gradational.

Note: Wells shown in bedrock are located in stream sediments recharged by District activities.

Figure 5-10

Nitrate Concentrations in Principal Aquifer Zone 2003

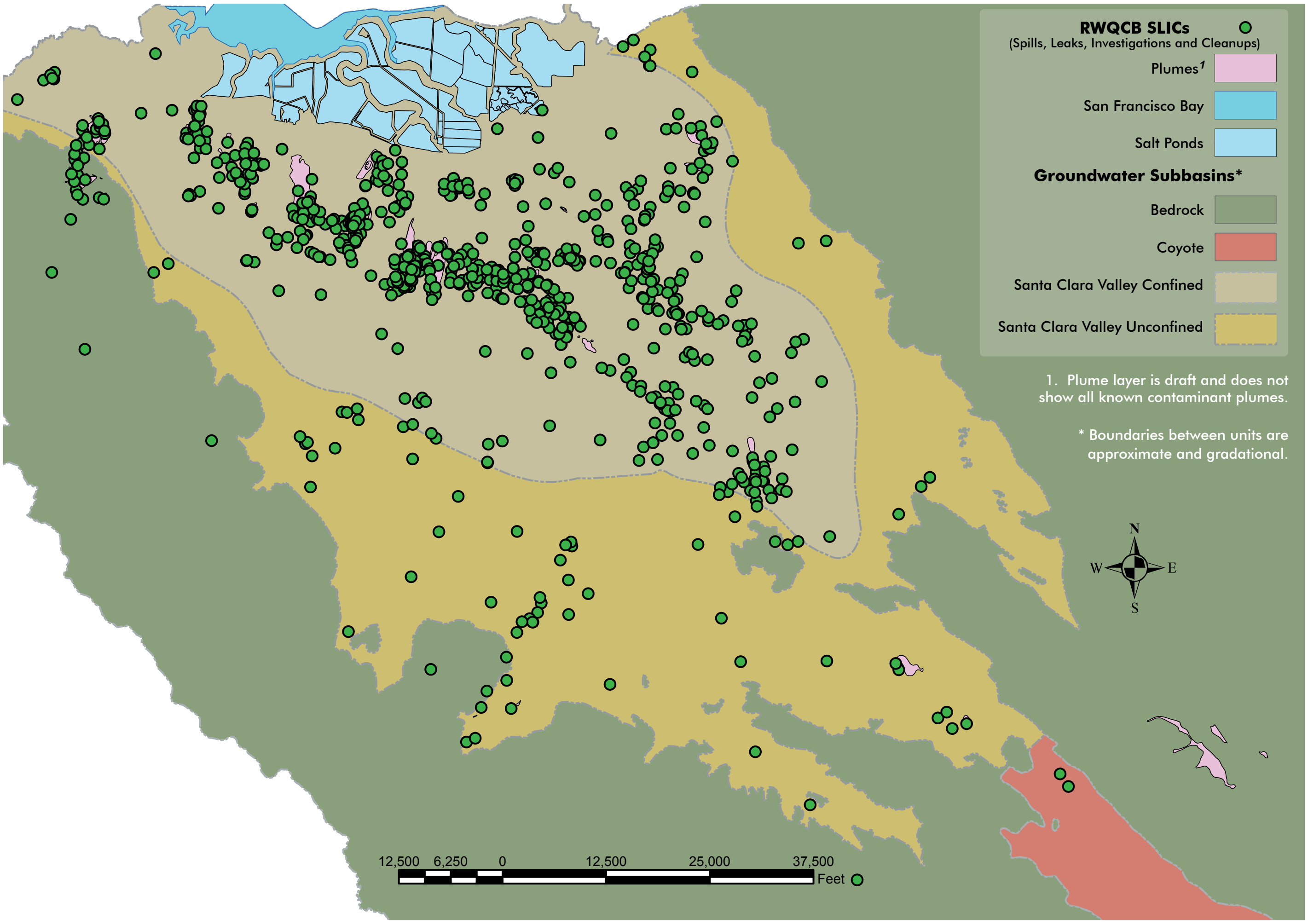


* Boundaries between units are approximate and gradational.

Note: Wells shown in bedrock are located in stream sediments recharged by District activities.

Figure 5-11

North County Plumes and SLIC Cases



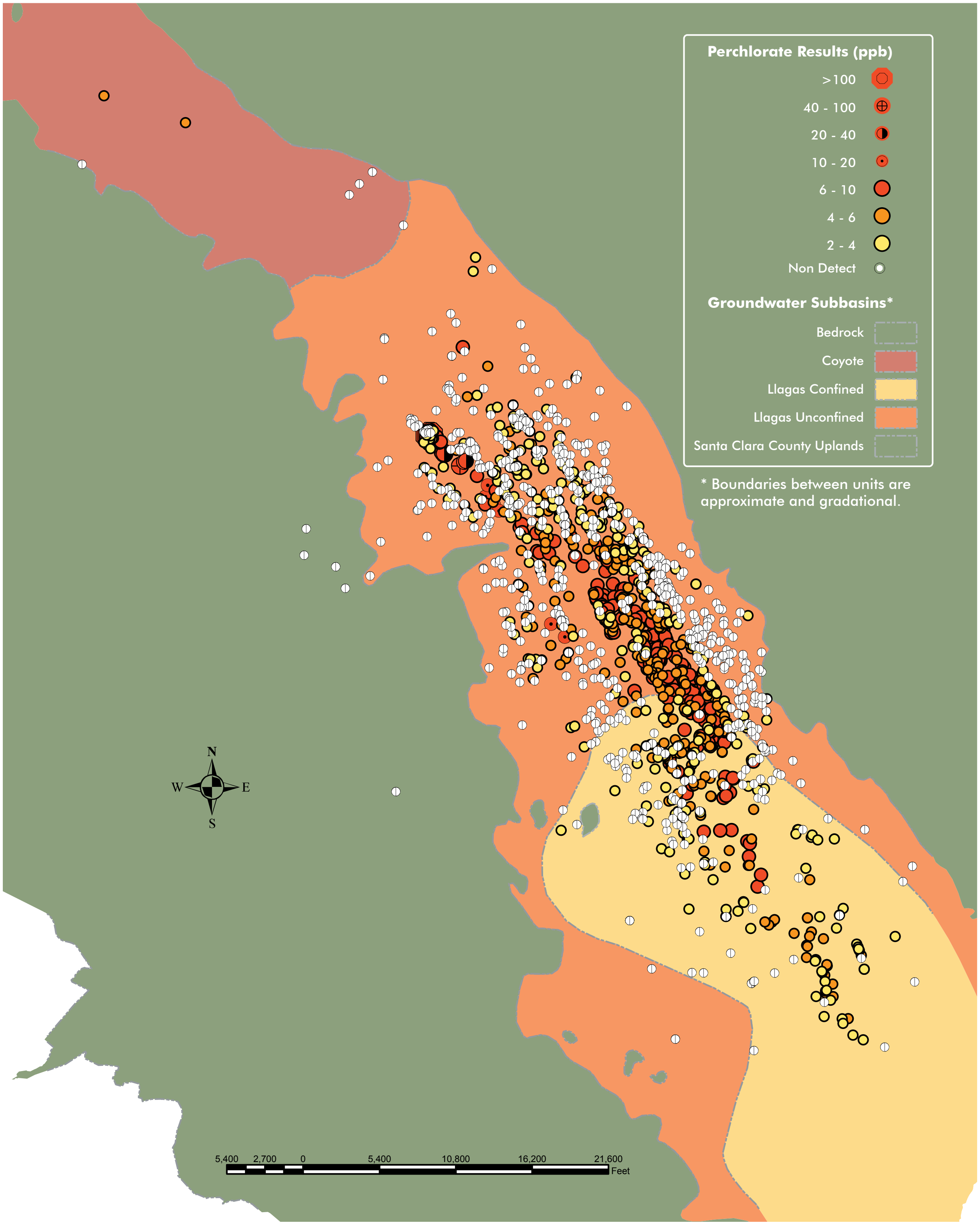
1. Plume layer is draft and does not show all known contaminant plumes.

* Boundaries between units are approximate and gradational.

"

Figure 5-12

Maximum Perchlorate Concentrations



Related Groundwater Projects

6.0 RELATED GROUNDWATER PROJECTS

6.1 Improving the Groundwater Monitoring Network

6.1.1 Depth-Discrete Monitoring Wells

The District is updating the existing Groundwater Elevation Monitoring Network to target monitoring wells where discrete, depth specific groundwater elevations can be obtained. In the Santa Clara Valley Subbasin, 15 aquifer-specific wells from other organizations were transferred to District ownership as of 2003. The program includes improving the network to collect depth-specific groundwater elevation and groundwater quality data at several locations in the northern Santa Clara Valley. The data obtained through this project are providing the District with a better understanding of the hydrogeologic features of the Santa Clara Valley Subbasin, and improving the District's ability to manage and protect groundwater resources.

In June 2000, the District Board of Directors approved a four-year cooperative study with the USGS to complete up to seven multiple-well monitoring sites in the Santa Clara Valley Subbasin. These wells will allow the District to obtain depth-specific groundwater elevation and quality data at strategic locations throughout the subbasin. In addition, the District successfully obtained a grant for $250,000 from the California Department of Water Resources to improve the groundwater monitoring network through the construction of two additional multiple-well monitoring sites. Eight sites have been completed (Figure 6-1) at the following locations: Coyote Creek Outdoor Classroom (CCOC) site (October 2000), in Willow Glen (April 2001); at the McGlincey Percolation Ponds (August 2001); near Santana Park (April 2002); near Guadalupe River (2002); near Eleanor Park in Palo Alto (2003); near Saratoga Creek in San Jose (2003); and near Evergreen (2003). One additional well in Mountain View is planned to be installed later. Due to budget constraints, the Mountain View site will be a single-well installation, rather than a multiple well site. Groundwater elevation data will be collected on a monthly basis, and a comprehensive suite of groundwater quality data will be obtained annually.

Other wells installed by the District included one well at Coyote Narrows for monitoring water quality and water levels; wells to monitor shallow groundwater in the vicinity of an underground storage tank at the District's maintenance yard; and wells to monitor groundwater in the vicinity of recycled water application near Christmas Hill Park in the Llagas Subbasin.

6.2 Improving Groundwater Modeling

The District is working to upgrade the existing Santa Clara Valley Subbasin groundwater flow model to simulate wells pumping from multiple aquifers, land subsidence, faults as horizontal flow barriers, and streamflow routing. These upgrades will allow for improved simulation of the North County, and will increase the usefulness of the model as a tool for groundwater management in that region. The District took delivery of a new Santa Clara Valley (North County) groundwater model in late 2003. This model, a revised version of MODFLOW, by the USGS, includes many new features, including stream flow routing, subsidence estimation, dynamic multi-aquifer well pumping, and horizontal flow barrier packages. The new model also has a denser grid and monthly stress periods instead of quarterly periods. The new model is currently being reviewed. The District began development and calibration of groundwater flow models for the Coyote and Llagas Subbasins during 2004.

6.3. Forecasting Groundwater Conditions

To forecast groundwater conditions in the Santa Clara Valley Subbasin for the 2003 calendar year, the District used the North County groundwater model with various assumptions for rainfall and water use. Rainfall assumptions were based on a 90 percent exceedence level. A 90 percent exceedence level means that there is a 90 percent chance that rainfall amounts will exceed the levels used in the assumptions; therefore, it represents a drought condition, or conservative approach. The 2003 water use assumptions were developed as part of the Integrated Water Resources Plan (IWRP) process. Other assumptions used in the modeling are based on the rainfall and operational assumptions. They include the amount of water treated by District facilities, the amount of Hetch Hetchy water deliveries, and the amount of water provided by both San Jose Water Company and Stanford. Agricultural uses and recharge due to sewer system leaks were also included, but these have a minimal effect on the subbasin as they do not vary significantly year to year.

The forecast of groundwater conditions in the Santa Clara Valley Subbasin in 2004 is based on modeling using the North County groundwater model The simulation shows that, even if drought conditions occur in 2004, groundwater elevations are still well above levels that cause subsidence in most areas and that in some areas artesian conditions would still exist. The groundwater subbasins should be able to meet groundwater demands in 2004 without creating adverse conditions.

The forecast of groundwater conditions in the Coyote and Llagas Subbasins in 2004 is based on recent trends in groundwater levels and storage. The forecast for these subbasins is a continued decline in groundwater elevations and therefore storage. This prediction is based on the recent trend of declining groundwater levels. Not withstanding this drop in groundwater levels, there should still be sufficient groundwater to meet South County demands in 2004.

6.4 Groundwater Management Plan Update

The District published its Groundwater Management Plan report in July 2001. The plan formally documented the District's groundwater management goals and described programs in place designed to meet those goals. The following programs were documented in the plan:

- Groundwater supply management programs that replenish the groundwater subbasins, sustain the subbasins' water supplies, help to mitigate groundwater overdraft, and sustain storage reserves for use during dry periods
- Groundwater monitoring programs that provide data to assist the District in evaluating and managing the groundwater subbasins
- Groundwater quality management programs that identify and evaluate threats to groundwater quality and prevent or mitigate contamination associated with those threats

According to Senate Bill 1938 signed into law on September 15, 2002, groundwater management agencies need to incorporate some new components into their groundwater management plan updates in order to qualify for funding administered by the California Department of Water Resources (DWR) for groundwater or groundwater quality projects.

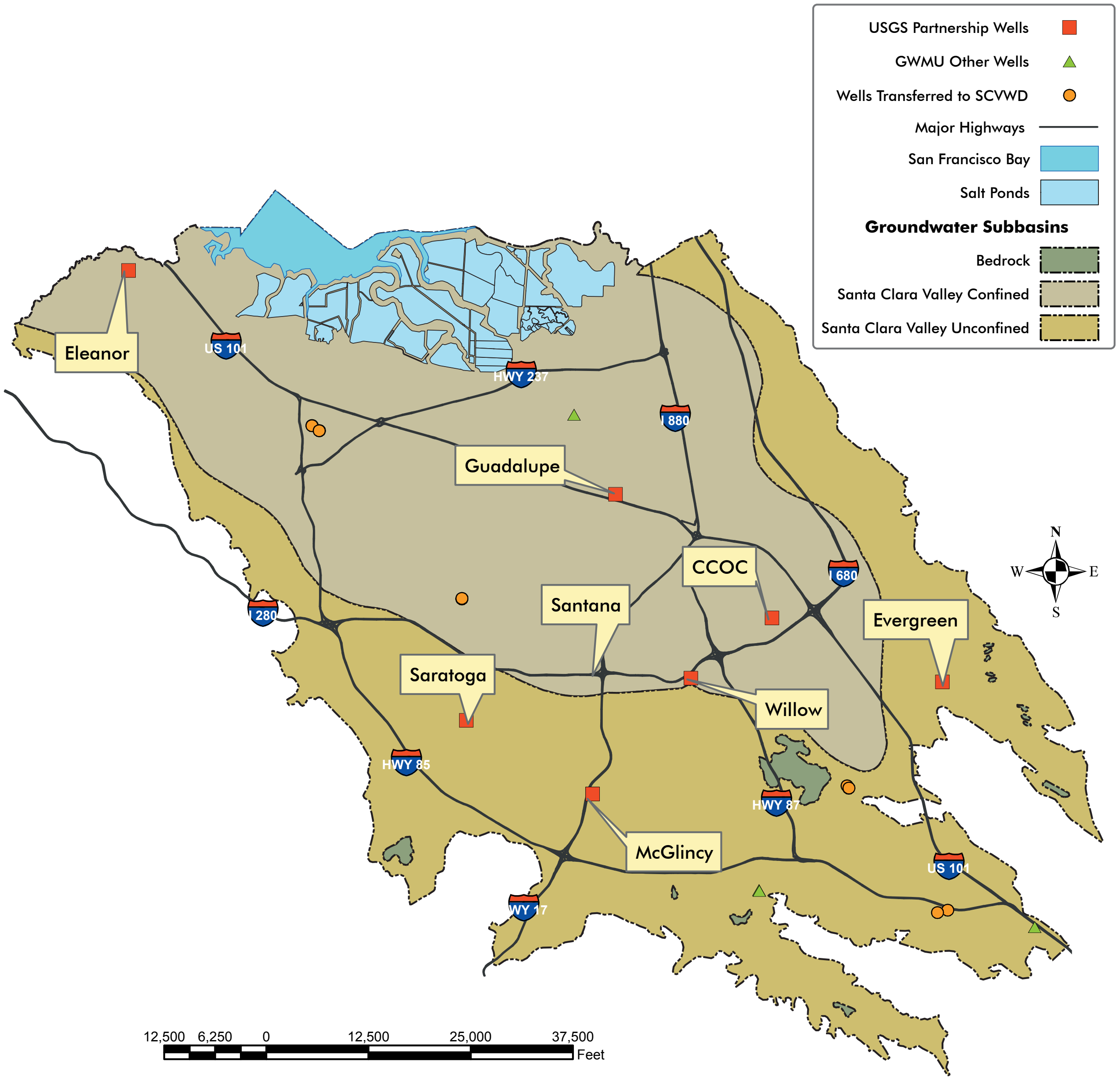
The District's groundwater management plan update, scheduled for completion on December 2005, will include the following new components:

- A map showing the area of the groundwater basin, as defined by DWR Bulletin 118, with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan
- The establishment of basin management objectives (BMOs) for the groundwater basin that is subject to the plan
- Monitoring protocols for the components mentioned above

Related Groundwater Projects

Figure 6-1

Depth Discrete Groundwater Monitoring Wells



7.0 New Groundwater Legislation and Regulations

7.1 Groundwater Legislation in 2002

Several bills related to groundwater were passed by the California State Legislature and signed into law in 2002. The laws that could have an impact on District operations are summarized below.

AB 2436 (Frommer) Land Use Restrictions: Cleanup And Abatement

This law institutes requirements for maintaining and tracking land use restriction, or "Environmental Restrictions," and applies to the California Environmental Protection Agency (Cal-EPA), the California Integrated Waste Management Board, the State Water Resources Control Board, the California regional water quality control boards, and the Department of Toxic Substances Control. The environmental restrictions specify requirements for protecting present or future human health or safety or the environment as a result of the presence on the land of hazardous materials. This law improves on agencies' ability to track land use restrictions and, therefore, the District's ability to rely on such restrictions to protect human health and safety and the environment now and in the future.

AB 2481 (Frommer) Underground Storage Tanks: Unified Program Agencies: Porter-Cologne Water Quality Control Act: Administrative Civil Penalties: Drinking Water: Enforcement

This law updates numerous provisions governing underground storage tank programs (UST), certified unified program agencies (CUPA), and enforcement provisions under the Porter Cologne Water Quality Control Act. The law includes enhanced leak detection testing requirements, which should result in improved early detection of leaking underground storage tank systems and fewer and lesser impacts to groundwater quality. The law also reestablishes the Drinking Water Treatment and Research Fund ("drinking water fund") until January 1, 2010.

The drinking water fund enables the State Department of Health Services (DHS) to make payments to public water systems (PWSs) for the costs of treating groundwater and surface water supplies contaminated with fuel oxygenates, investigating the contamination, and acquiring alternate water supplies. DHS can also spend up to $1 million per year for research into treatment technologies. The funding could assist the District or retailers if local water sources become contaminated with fuel oxygenates and require treatment or replacement.

SB 1822 (Sher) Public Water Systems: Public Health Goals: Perchlorate

This new law requires the Office of Environmental Health Hazard Assessment (OEHHA) to perform a risk assessment on perchlorate (found naturally occurring and from rocket fuel by-products) and to adopt a Public Health Goal (PHG) by January 1, 2003. The law requires the California Department of Health Services to adopt a primary drinking water standard for perchlorate in public drinking water systems. Perchlorate has been detected in some public water supply wells. Therefore, depending on the level at which the drinking water standard is set, some local retailers may need to treat some of their well water or develop alternative water supplies to meet their demands.

SB 1938 (Machado) Groundwater Management: State Funding

This new law requires a local agency seeking state funds for groundwater-related projects that directly affect groundwater levels or quality, to prepare and implement a groundwater management plan that includes components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic subsidence, and surface water and groundwater interactions. The law also requires the local agency to prepare a plan for involving and working cooperatively with other agencies in preparing the groundwater management plan. Agencies, such as the District, with an existing groundwater management plan that meets SB 1938 requirements would be eligible for state funding and given priority for funding over agencies without a plan.

7.2 Groundwater Legislation in 2003

Several bills related to groundwater were passed by the California State Legislature and signed into law in 2003. The laws that could have an impact on District operations or groundwater conditions are summarized below.

AB 826 (Jackson) The Perchlorate Contamination Prevention Act: Perchlorate Materials: Statewide Data Base

The new law requires the Department of Toxic Substances Control to establish standards for best management practices (BMPs) for the handling of perchlorate materials by December 31, 2005. BMPs should help minimize future impacts from perchlorate.

AB 826 also establishes a program, as funding becomes available, within the California Environmental Protection Agency (CalEPA) for the collection and maintenance of a statewide database of information relating to all facilities or sites where perchlorate waste may have been discharged, and will make the non-confidential information available to the public on the Internet. CalEPA will incorporate the information from Certified Unified Program Agencies (CUPAs) regarding hazardous materials use and spills. Priority for collection of data shall be given to materials that the Secretary of CalEPA determines to be of greatest concern. The database will eventually help track legacy releases of groundwater contaminants.

AB 998 (Lowenthal) Air Quality: Nontoxic Dry Cleaning Incentive Program

SB 998 requires the state board to impose a $3 per gallon fee on every manufacturer of perchloroethylene (PCE) in the state, and on every person that imports PCE into the state for use in dry cleaning, and to deposit the revenues generated by that fee in the Nontoxic Dry Cleaning Incentive Trust Fund. The Fund, which will be administered by the State Air Resources Board, will be used for grant and demonstration programs. The grant program would provide $10,000 grants to eligible dry cleaners who currently use PCE to aid transitions to dry cleaning systems that are nontoxic and nonsmog-forming. The nontoxic and nonsmog forming systems are lower threats to groundwater than PCE systems.

AB 1218 (Dutra) Underground Storage Tanks: Claims: Performance-Based Contracts: Fire Safety Agency Claims

This measure, sponsored by the District, authorizes the use of performance based contracts for environmental cleanup under the state's leaking underground storage tank program. It allows the use of Pay for Performance (PFP) or performance-based contracts as an option for achieving environmental cleanup of leaking underground storage tank (UST) sites. The law enables the State Water Resources Control Board to begin to facilitate the fair bidding of pay for performance contracts, including advertising PFP contracts on their web site. AB 1218 will result in faster site remediation at the state's UST sites where performance-based contracts are employed.

SB 1002 (Sher): Santa Clara Valley Water District

This measure, sponsored by the District, ratifies the FY 2002/2003 Underground Storage Tank Local Oversight Program (LOP) contract between the District and the State Water Resources Control Board from 1988 through January 1, 2004 and sunsets the District's definition as a "local agency" for these purposes on June 30, 2004. As a result of the sunset clause, the District will not be able to contract with the State Board as a local agency for the LOP after FY 2004. This will result in a transfer of local agency responsibilities for the LOP to the County of Santa Clara beginning in July 2004.

SB 1004 (Soto): Resources

SB 1004 codifies that Cleanup and Abatement Orders may require the provision of, or payment for, replacement water to public water suppliers and private well owners. It also outlines new law for settlement discussions and non-binding mediations related to the water replacement plan.

SB 1004 also establishes a database collection system under the auspices of the State Water Resources Control Board for reporting on perchlorate storage facilities that have stored over 500 lbs of perchlorate in any calendar year since January 1, 1950 and requires that the list be published and made accessible to the public by January 1, 2006. The bill also establishes civil penalties for reporting negligence on the part of person(s) who discharge 10 lbs or more of perchlorate into the waters of the state.

The clarification of the Water Code related to replacement water is important to the District and local well owners who are affected by perchlorate. The database collection system established by the bill may make it easier to assess impacts from perchlorate.

7.3 New Regulations for 2002

No new regulations were passed for groundwater in 2002.

7.4 New Regulations for 2003

Executive Order S-2-03

On November 17, 2003 Governor Arnold Schwarzenegger signed Executive Order S-2-03, placing a six month freeze on new regulations that may impact the economy. The regulations are under review by the Office of Administrative Law. Regulations that pertain to emergency situations, health or safety are exempt. The impact of the freeze on the regulatory process remains unclear.

Revised Maximum Contaminant Levels

The California Department of Health Services revised several Maximum Contaminant Levels (MCLs) in June 2003. The MCLs for the following chemicals were lowered to the indicated level:

Table 7-1

Revised Maximum Contaminant Levels

Chemical	Maximum Contaminant Level (milligrams per liter)
Cyanide	0.15
Ethylbenzene	0.3
1,2,4-Trichlorobenzene	0.005
Atrazine	0.001
Methoxychlor	0.03
Oxamyl	0.05

In addition, the Detection Limit for Reporting for Atrazine was lowered to 0.0005 milligrams per liter.

Summary

8.0 Summary

Groundwater is an essential component of the overall water supply for Santa Clara County, supplying nearly half of the total water used. As such, protection of groundwater resources is vital to the growth and prosperity of the County. The District's numerous groundwater management programs demonstrate that the District is proactive and vigilant in terms of sustaining and protecting the County's groundwater resources.

The purpose of this 2002/2003 Groundwater Conditions Report is to describe and document conditions within the County's three groundwater subbasins for calendar years 2002 and 2003. Results from District programs to monitor groundwater elevation, land subsidence, and groundwater quality are summarized below.

8.1 Groundwater Use and Recharge

Approximately 157,800 acre-feet of groundwater was extracted for beneficial use in 2002; this accounts for 41 percent of the total 382,400 acre-feet of water used in Santa Clara County. Approximately 104,800 acre-feet of groundwater was withdrawn from the Santa Clara Valley Subbasin; this includes approximately 104,100 acre-feet for municipal and industrial (M&I) uses, with approximately 700 acre-feet used for agriculture. Approximately 53,000 acre-feet of groundwater was extracted from the Coyote and Llagas Subbasins in 2002; with approximately 25,500 acre-feet used for M&I uses and 27,500 acre-feet for agriculture.

In 2003, approximately 146,900 acre-feet of groundwater was extracted for beneficial use; this accounts for 40 percent of the total 365,700 acre-feet used in Santa Clara County. Approximately 96,600 acre-feet of groundwater was withdrawn from the Santa Clara Valley Subbasin; this included approximately 96,200 acre-feet for M&I uses, with about 400 acre-feet used for agriculture. Approximately 50,300 acre-feet of groundwater was extracted from the Coyote and Llagas Subbasins in 2003, with approximately 24,300 acre-feet used for M&I purposes and 26,000 acre-feet for agriculture.

Through artificial recharge operations, approximately 107,300 acre-feet of water recharged the groundwater subbasins through in-stream and off-stream recharge facilities in 2002. Approximately 72,000 acre-feet of water recharged the Santa Clara Valley Subbasin through artificial recharge; this includes 27,100 acre-feet through off-stream ponds and 44,900 acre-feet through the in-stream recharge program. Approximately 35,300 acre-feet of water recharged the Coyote and Llagas Subbasins through artificial recharge, including 6,400 acre-feet through off-stream ponds and 28,900 acre-feet through in-stream recharge.

In 2003, approximately 118,100 acre-feet of water recharged the groundwater subbasins through in-stream and off-stream recharge facilities. Approximately 74,800 acre-feet of water recharge the Santa Clara Valley Subbasin through artificial recharge operations; this included 36,400 acre-feet through off-stream ponds and 38,400 acre-feet through the in-stream recharge program. Approximately 43,400 acre-feet of water recharge thee Coyote and Llagas Subbasin through artificial recharge operations, including 4,500 acre-feet through off-stream ponds and 38,900 acre-feet through in-stream recharge.

Natural and artificial recharge less groundwater withdrawals resulted in the following net change in storage. Storage in the Santa Clara Valley Subbasin increased by approximately 11,000 to 13,000 acre-feet in 2002 and increased by approximately 15,000 to 17,000 acre-feet in 2003. In South County, there was a net decrease in the storage of the Coyote and Llagas Subbasins, of approximately 15,000 to 17,000 acre-feet in 2002 and a net increase in storage of the Coyote and Llagas Subbasins of approximately 13,000 to 15,000 acre-feet in 2003.

8.2 Groundwater Elevation Monitoring Summary

In general, groundwater elevations throughout the County were high in 2002 and 2003, due to near-normal rainfall years and active groundwater recharge. Although referred to as groundwater elevations, the elevations actually measured in the confined aquifer reflect pressure. Current groundwater elevations in the Santa Clara Valley Subbasin index well are approximately 28 feet below the historic maximum levels and are over 200 feet above the minimum groundwater levels recorded over the 89-year historical record. Additionally, the minimum 2002 and 2003 groundwater elevation recorded in the fall is approximately 63 feet above the subsidence threshold, which is one of the District's performance measures to ensure "Groundwater supplies are sustained" in accordance with Board Ends Policy. While groundwater elevations in the Llagas Subbasin index well remain above the performance measure target elevation, groundwater elevations have been declining for the last several years. Overall, 2002 and 2003 data indicate that the District is exceeding the performance measures established to ensure "Groundwater supplies are sustained."

8.3 Land Subsidence Monitoring Summary

As a result of significant historical land subsidence in the North County, the District monitors land subsidence throughout the Santa Clara Valley Subbasin. Monitoring at two extensometers, eight subsidence index wells, and 147 surface benchmarks in 2002 and 2003 indicates that any residual subsidence that is occurring is within the tolerable range established by the District. Monitoring at benchmark P7 indicates that the District exceeds the related performance measure designed to ensure "Groundwater supplies are sustained." In general, monitoring data from 2002 and 2003 indicate that land subsidence in the Santa Clara Valley Subbasin is minimized by the District's proactive groundwater management activities.

8.4 Groundwater Quality Monitoring Summary

Overall groundwater quality in Santa Clara County is very good and water quality objectives were achieved in almost all wells. The most significant exception is nitrate, which continues to be a concern in the Llagas and Coyote Subbasins. The nitrate drinking water standard was exceeded in 33 wells in 2002 and in 39 wells in 2003. Some of these are upper zone monitoring wells and others are agricultural supply wells. However, the drinking water standard for nitrate was exceeded in 25 wells in 2002 and in 19 wells in 2003 whose primary use is municipal or domestic supply, necessitating blending or treatment prior to delivery to customers. The District is continuing to implement a comprehensive nitrate management program to reduce nitrate exposure, reduce nitrate loading, and monitor groundwater quality.

Drinking water standards for other inorganic constituents were exceeded in 48 wells in 2002 and in 44 wells in 2003. However, all these exceedences were for naturally occurring constituents, and all but one of the exceedences were for secondary standards. Secondary standards are based on protecting consumers from adverse tastes, odors, or appearance and such exceedences do not pose a health risk. One well sample contained aluminum concentrations in excess of the primary, health-based drinking water standard in 2002.

The agricultural water quality objective for boron was exceeded in 14 wells in 2002 and in 13 wells in 2003, and the agricultural objective for selenium was exceeded in one well in 2002.

VOCs were detected below drinking water standards in 22 wells in 2002 and in 20 wells in 2003. One SOC, di(2 ethylhexyl)phthalate, was detected above its drinking water standard in one well in 2002.

District Board Ends Policy directs staff to ensure "The groundwater basins are aggressively protected from contamination and the threat of contamination." The Chief Executive Officer's interpretation of this policy is "Index wells should not have contaminant concentrations that exceed water quality objectives". The data summarized in this report show that, for the most part, groundwater management programs achieve the desired end. The nitrate standard was the only drinking water standard for an anthropogenic constituent that was exceeded in drinking water supply wells and it was exceeded in a very small percentage of wells. The District continues to implement a comprehensive nitrate management program to monitor nitrate occurrence, reduce consumer exposure to nitrate in drinking water, and reduce nitrate loading throughout the basin. The goal of the nitrate management program is to reduce nitrate concentrations in groundwater so that all wells meet the drinking water standard for nitrate.

The District will continue monitoring groundwater quality and collecting public water supply well data from DHS.

8.5 Future Work

The District will continue to summarize the annual results of groundwater elevation, groundwater quality, and land subsidence monitoring programs in future Groundwater Conditions reports. The results of the District's groundwater monitoring programs are used to evaluate current groundwater conditions, to optimize recharge efforts, to assess groundwater storage and groundwater quality, and to support modeling efforts. Rigorous groundwater monitoring and analysis of these data are critical to ensuring the long-term viability of groundwater as part of the County's water supply.

DHS, 2002, Preparing Your California Drinking Water Consumer Confidence Report (CCR):

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